This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Digitized by Google

STANFORD UNIVERSITY
GOV'T DOCUMENTS DEPARTMENT

Digitized by Google

C 3.5: C33/2
NON CIRC

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

DEPARTMENT OF COMMERCE AND LABOR

BUREAU OF THE CENSUS

E. DANA DURAND, DIRECTOR

SPECIAL REPORTS

CENTRAL ELECTRIC LIGHT AND POWER STATIONS

1907

WASHINGTON

GOVERNMENT PRINTING OFFICE

1910

Digitized by Google

C 3.222:900/SPR/EP

137835

STANFORD LIBRARY

Digitized by Google

CONTENTS.

CHAPTER I.

Scope and Grouping of the Statistics.

Page.

Central stations 13
Municipal stations 13
Electric-railway plants and central electric stations 13
Isolated plants 14
Power or generating plants 14
Period covered 14
Basis of canvass 15
Grouping of statistics 15

CHAPTER II.

Summary of Statistics.

Table 1.—Commercial and municipal central electric stations: 1907 and 1902 16
Table 2.—Central electric stations operated by street-railway companies: 1907 and 1902 17
Ownership of central electric stations 17
Table 3.—Commercial central electric stations—Number, by character of ownership: 1907 and 1902 17
Table 4.—Commercial central electric stations, by character of ownership: 1907 18
Table 5.—Purely electric and composite central electric stations, by character of ownership: 1907 19
Table 6.—Purely electric and composite central electric stations—Commercial and municipal: 1907 and 1902 20
Relationship of population and central stations 20
Table 7.—Central electric stations—Relation of leading items to population, by geographic divisions: 1907 and 1902 22
Thirty-four selected cities grouped in four classes according to their estimated population in 1902 23
Table 8.—Central electric stations in 34 selected cities, by groups, according to population: 1907 and 1902 24
Table 9.—Central electric stations in 34 selected cities—Income from "All other electric service:" 1907 and 1902 25
Table 10.—Central electric stations in 34 selected cities—Generating equipment: 1907 and 1902 25
Large and small stations 26
Table 11.—Commercial and municipal central electric stations—Number, by dynamo capacity of stations: 1907 and 1902 26
Table 12.—Purely electric and composite central electric stations—Number, by dynamo capacity of stations: 1907 and 1902 27
Table 13.—Central electric stations—Number, by dynamo capacity and by geographic divisions: 1907 and 1902 27
Consolidation of electric stations with other enterprises 27
Commercial and municipal central electric stations—Number and kind of associated enterprises: 1907 27
Table 14.—Comparative summary—Central electric stations and gas plants 28
Municipal plants 28–34
Table 15.—Municipal central electric stations—Number, with additions since 1902, by geographic divisions: 1907 29
Table 16.—Municipal central electric stations—Number, by population of cities in which located and by geographic divisions: 1907 and 1902 29
Table 17.—Municipal central electric stations, by population of cities in which located and by geographic divisions: 1907 and 1902 30
Table 18.—Municipal central electric stations which supply the entire electric service in the cities where located, by geographic divisions: 1907 and 1902 32
Table 19.—Municipal central electric stations which do not supply the entire electric service in the cities where located, by geographic divisions: 1907 and 1902 33
Municipal central electric stations that render the entire electric service and those that do not—Per cent distribution of income, by geographic divisions: 1907 34

CHAPTER III.

Power Equipment.

Primary-power equipment of central stations and electric railways 35
Table 20.—Central electric stations and electric railways—Number and horsepower of the primary-power machines, by kind of power: 1907 and 1902 35

Digitized by Google

Page.
Central stations ... 35–50
Engines and water wheels ... 35
Table 21.—Commercial and municipal central electric stations—Number and horsepower of the primary-power machines, by kind of power: 1907 and 1902 ... 36
Table 22.—Commercial and municipal central electric stations—Per cent distribution, by kind of primary-power machines: 1907 and 1902 ... 38
Steam engines and steam turbines ... 38
Table 23.—Commercial and municipal central electric stations—Steam engines and steam turbines, by horsepower capacity: 1907 and 1902 ... 38
Table 24.—Commercial and municipal central electric stations—Per cent distribution, by number and horsepower capacity of steam engines and steam turbines: 1907 and 1902 ... 39
Table 25.—Commercial and municipal central electric stations—Number and horsepower of steam engines, exclusive of steam turbines: 1907 and 1902 ... 39
Table 26.—Commercial and municipal central electric stations—Per cent distribution, by number and horsepower capacity of steam engines, exclusive of steam turbines: 1907 and 1902 ... 41
Steam turbines ... 41
Table 27.—Commercial and municipal central electric stations—Number and horsepower of steam turbines, by horsepower capacity, with per cent distribution: 1907 ... 41
Table 28.—Central electric stations in selected cities—Number and horsepower of steam turbines: 1907 ... 42
Gas engines ... 42
Internal-combustion oil engines ... 42
Internal-combustion oil engines—Number and horsepower, by states: 1907 ... 42
Water power ... 42
Table 29.—Commercial and municipal central electric stations—Number and horsepower of water wheels, by horsepower capacity: 1907 and 1902 ... 43
Table 30.—Commercial and municipal central electric stations—Per cent distribution, by number and horsepower capacity of water wheels: 1907 and 1902 ... 43
Table 31.—Commercial and municipal central electric stations—Average horsepower, per station and per machine, of primary power: 1907 and 1902 ... 43
Commercial and municipal central electric stations—Distribution by number of stations, and kinds of primary power: 1907 and 1902 ... 44
Dynamos, central stations, and electric railways ... 44
Table 32.—Central electric stations and electric railways—Number and kilowatt capacity of dynamos in generating stations, by kind of dynamo: 1907 and 1902 ... 44
Table 33.—Central electric stations and electric railways—Per cent distribution, by kind and by number and capacity of dynamos: 1907 and 1902 ... 45
Dynamos in central stations ... 45
Table 34.—Commercial and municipal central electric stations—Number and kilowatt capacity of dynamos in generating stations, by kind of dynamo: 1907 and 1902 ... 46
Table 35.—Commercial and municipal central electric stations—Per cent distribution, by kind and by number and capacity of dynamos: 1907 and 1902 ... 46
Table 36.—Commercial and municipal central electric stations—Average kilowatt capacity of dynamos, by kind, per station, and per machine: 1907 and 1902 ... 46
Commercial and municipal central electric stations—Number of stations, by kind of dynamo: 1907 and 1902 ... 46
Table 37.—Central electric stations—Kind of dynamos, by class, number, and kilowatt capacity: 1907 ... 47
Table 38.—Commercial and municipal central electric stations—Dynamos, by number and kilowatt capacity: 1907 ... 47
Table 39.—Central electric stations—Kilowatt capacity of dynamos in the states which increased their capacity over 20,000 kilowatts: 1907 and 1902 ... 49
Table 40.—Commercial and municipal central electric stations—Number and kilowatt capacity of miscellaneous main-station equipment: 1907 and 1902 ... 49
Table 41.—Commercial and municipal central electric stations—Number and kilowatt capacity of substation equipment, by kind: 1907 and 1902 ... 49
Output of stations ... 50, 51
Table 42.—Central electric stations and electric railways—Output of generating stations: 1907 and 1902 ... 50
Table 43.—Commercial and municipal central electric stations—Output of generating stations: 1907 and 1902 ... 50
Table 44.—Central electric stations—Output of generating stations, by states and territories, with per cent of increase and per cent distribution of total increase: 1907 and 1902 ... 51

CHAPTER IV.

Line Equipment.

Central stations and electric railways ... 52
Table 45.—Central electric stations and electric railways—Lamps, meters, transformers in circuits, and stationary motors: 1907 and 1902 ... 52

Digitized by Google

Page.
Central stations ... 52–60
Lamps, meters, transformers, and stationary motors ... 52
Table 46.—Commercial and municipal central electric stations—Lamps, meters, transformers in circuits, and stationary motors: 1907 and 1902 ... 53
Arc lamps ... 53
Table 47.—Commercial and municipal central electric stations—Arc lamps, by kinds: 1907 and 1902 ... 53
Commercial and municipal central electric stations—Per cent distribution of arc lamps, by kind: 1907 and 1902 ... 54
Table 48.—Commercial and municipal central electric stations—Arc lamps, by kind of current used: 1907 and 1902 ... 54
Table 49.—Commercial and municipal central electric stations—Per cent distribution of arc lamps, by kind of current used: 1907 and 1902 ... 54
Incandescent lamps ... 54
Table 50.—Commercial and municipal central electric stations—Incandescent lamps, by candlepower, and other varieties of lamps: 1907 and 1902 ... 55
Central electric stations—Number, by lamp equipment: 1907 ... 56
Table 51.—Central electric stations—Arc and incandescent lamps, for the 8 states having the largest numbers of incandescent lamps: 1907 and 1902 ... 56
Central electric stations—Lamps other than regular arc and incandescent, by kind: 1907 ... 57
Meters on consumption circuits ... 57
Table 52.—Central electric stations—Meters on consumption circuits, for the 8 states having the greatest numbers of meters: 1907 and 1902 ... 57
Transformers in circuits for customers ... 58
Table 53.—Central electric stations—Number and kilowatt capacity of transformers in circuits for customers, for the 8 states having the greatest kilowatt capacity: 1907 and 1902 ... 58
Stationary motors ... 58
Table 54.—Central electric stations—Number and horsepower capacity of stationary motors, for the 8 states having the greatest horsepower capacity: 1907 and 1902 ... 59
Table 55.—Commercial and municipal central electric stations—Number of stations, by character of service: 1907 and 1902. 59
Average size of station ... 59
Table 56.—Commercial and municipal central electric stations—Average number of lamps, meters, transformers, and motors per station and average capacity per machine: 1907 and 1902 ... 60
Line construction ... 60

CHAPTER V.

Capitalization.

Basis of statistics ... 61
Increase since 1902 ... 61
Table 57.—Capital stock, funded debt, dividends, and interest paid on funded debt of commercial companies, and funded debt and interest of municipal stations having bonds outstanding: 1907 and 1902 ... 61
Capitalization of commercial companies ... 61
Average rate of return on capitalization of incorporated companies: 1907 and 1902 ... 62
Capitalization of purely electric and composite companies ... 62
Table 58.—Purely electric and composite companies—Capital stock, funded debt, dividends, and interest: 1907 ... 63
Table 59.—Distribution of capitalization, dividends, and interest between the electric light and power industry and allied industries: 1907 ... 63
Capitalization and cost of construction ... 64
Analysis of dividends and interest ... 64
Table 60.—Analysis of dividends and interest: 1907 ... 64
Table 61.—Capitalization—Amount, dividends, and interest for companies paying either dividends on stock or interest on funded debt, and amount for companies paying neither dividends nor interest: 1907 ... 64
Table 62.—Capital stock—Amount and dividends for companies paying dividends either on common or preferred stock, and amount for companies not paying dividends: 1907 ... 65
Table 63.—Common stock—Amount and dividends for companies paying dividends, grouped by rate of dividends, and amount for companies not paying dividends: 1907 ... 65
Table 64.—Preferred stock—Amount and dividends for companies paying dividends, grouped by rate of dividends, and amount for companies not paying dividends: 1907 ... 66
Table 65.—Funded debt—Amount and interest for companies paying interest and amount for companies not paying interest: 1907 ... 66
Table 66.—Companies reporting funded debt, grouped by rate of interest: 1907 ... 67
Capitalization statistics of companies, classified according to dynamo capacity ... 67
Table 67.—Capitalization statistics of commercial companies, classified according to dynamo capacity of stations: 1907 ... 67
Table 68.—Per cent distribution, by dynamo capacity, of number of companies, capitalization, and dividends and interest, and average capitalization per company: 1907 ... 68
Average capitalization per company and per cent distribution of capitalization for groups of companies, classified according to dynamo capacity: 1907 ... 68
Municipal stations ... 69
Table 69.—Municipal stations—Funded debt and interest: 1907 and 1902 ... 69
Table 70.—Municipal stations—Funded debt and interest for purely electric and composite stations: 1907 ... 69
Table 71.—Municipal stations—Distribution of funded debt and interest between the electric light and power industry and allied industries: 1907 ... 69

Digitized by Google

CHAPTER VI.

Cost of Construction and Equipment.

Page.
General discussion ... 70
Table 72.—Commercial and municipal central electric stations—Total cost of plants and equipment; average cost per kilowatt capacity of dynamos and per horsepower capacity of engines and water wheels; and cost of construction during the census year: 1907 and 1902 ... 70
Table 73.—Total cost of plants and equipment for states each of which in 1907 reported a total of more than $40,000,000: 1907 and 1902 ... 71
Table 74.—Notable increases in the total cost of construction for 20 selected states in 1907 over the amount reported in 1902 ... 71
Table 75.—Commercial and municipal central electric stations—Total cost of plants and equipment, by kind of primary power: 1907 and 1902 ... 72
Table 76.—Commercial and municipal central electric stations—Cost of plants and equipment, by kind of primary power used and by geographic divisions: 1907 and 1902 ... 72
Table 77.—Total cost of plants and equipment, by character of ownership: 1907 ... 73
Table 78.—Commercial and municipal central electric stations—Cost of construction during the year, by kind of primary power used and by geographic divisions: 1907 ... 73
Table 79.—Commercial central electric stations—Cost of construction during the year for selected states, by geographic divisions and kind of primary power: 1907 ... 74
Table 80.—Number of stations under construction, December 31, 1907, by character of ownership and by geographic divisions ... 74
Table 81.—Cost of construction and equipment of stations under construction, December 31, 1907, and capitalization of the incorporated companies, by character of ownership and by geographic divisions ... 74
Table 82.—Cost of construction and equipment of stations under construction, December 31, 1907, and capitalization of the incorporated companies, by kind of power used and by geographic divisions ... 75
Stations under construction, December 31, 1907—Number of stations, by kind of power and by character of ownership ... 75

CHAPTER VII.

Income and Expenses.

Purpose of the statistics ... 76
General statistics of income ... 76–89
Table 83.—Commercial and municipal central electric stations—Gross income: 1907 and 1902 ... 76
Table 84.—Commercial and municipal central electric stations—Per cent distribution of gross income: 1907 and 1902 ... 78
Table 85.—Purely electric and composite central electric stations—Gross income: 1907 and 1902 ... 78
Table 86.—Purely electric and composite central electric stations—Per cent distribution of gross income: 1907 and 1902 ... 79
Table 87.—Commercial and municipal central electric stations—Gross income, by dynamo capacity of stations: 1907 and 1902 ... 79
Table 88.—Commercial central electric stations—Gross income, by dynamo capacity of stations: 1907 and 1902 ... 80
Table 89.—Municipal central electric stations—Gross income, by dynamo capacity of stations: 1907 and 1902 ... 80
Table 90.—Purely electric commercial stations—Gross income, by dynamo capacity of stations: 1907 and 1902 ... 80
Table 91.—Composite commercial stations—Gross income, by dynamo capacity of stations: 1907 and 1902 ... 81
Table 92.—Purely electric municipal stations—Gross income, by dynamo capacity of stations: 1907 and 1902 ... 81
Table 93.—Composite municipal stations—Gross income, by dynamo capacity of stations: 1907 and 1902 ... 81
Table 94.—Central electric stations—Gross income for 10 selected states: 1907 and 1902 ... 82
Table 95.—Central electric stations—Per cent distribution and per cent of increase for gross income in 10 selected states: 1907 and 1902 ... 82
Table 96.—Commercial and municipal central electric stations—Gross income, by kind of primary power used: 1907 and 1902 ... 83
Table 97.—Commercial and municipal central electric stations—Per cent of increase of gross income, by kind of primary power used: 1907 ... 83
Table 98.—Commercial and municipal central electric stations—Per cent distribution of gross income for each kind of power used, by source of income: 1907 and 1902 ... 84
Table 99.—Commercial and municipal central electric stations—Gross income for stations with and without meters on consumption circuits: 1907 and 1902 ... 84
Table 100.—Commercial and municipal central electric stations—Gross income from commercial and public lighting: 1907 and 1902 ... 85
Table 101.—Central electric stations—Gross income from commercial and public lighting, for 15 selected states: 1907 and 1902 ... 86
Commercial central electric stations—Average income from lamps as reported in 1902, and as obtained from 110 selected reports in 1907 ... 86
Table 102.—Commercial and municipal central electric stations—Gross income from stationary-motor service, for 14 selected states: 1907 and 1902 ... 87
Table 103.—Commercial and municipal central electric stations—Gross income from "All other electric service:" 1907 and 1902 ... 87
Table 104.—Commercial and municipal central electric stations—Gross income from current sold to electric railways and to other electric companies, for 12 selected states: 1907 and 1902 ... 88
Table 105.—Commercial and municipal central electric stations—Income from electric service other than that for lighting, motor service, and current sold to railways and to other electric companies: 1907 ... 88

Digitized by Google

Page
Expenses ... 89–95
Table 106.—Commercial and municipal central electric stations—Expenses: 1907 and 1902 ... 89
Table 107.—Commercial and municipal central electric stations—Per cent that each item of expense is of total: 1907 and 1902. 90
Table 108.—Purely electric and composite central electric stations—Expenses: 1907 and 1902 ... 90
Table 109.—Purely electric and composite central electric stations—Per cent that each item of expense is of total: 1907 and 1902. 90
Table 110.—Commercial and municipal central electric stations—Expenses, by kind of primary power used: 1907 and 1902... 91
Table 111.—Commercial and municipal central electric stations—Per cent increase of expenses, by kind of primary power used: 1907 ... 91
Table 112.—Commercial and municipal central electric stations—Per cent distribution of total expenses for each kind of power used, by items of expense: 1907 and 1902 ... 91
Salaries and wages ... 92
Table 113.—Commercial and municipal central electric stations—Employees, salaries, and wages: 1907 and 1902 ... 92
Supplies and materials ... 93
Table 114.—Commercial and municipal central electric stations—Cost of supplies and materials: 1907 and 1902 ... 93
Fuel ... 94
Table 115.—Commercial and municipal central electric stations—Cost of fuel: 1907 and 1902 ... 94
Power purchased ... 94
Miscellaneous expenses ... 95
Table 116.—Commercial and municipal central electric stations—Miscellaneous expenses: 1907 and 1902 ... 95

CHAPTER VIII.

Technical Aspects of the Period.

By Thomas Commerford Martin, Expert Special Agent.

General conditions ... 96
Steam power ... 97
Oil engines ... 98
Gas engines ... 98
Water power ... 98
Generators ... 100
Transmission ... 102
Distribution ... 103
Transformers ... 104
Storage batteries ... 105
Arc lamps ... 106
Incandescent lamps ... 108
Electric power ... 113
Electric heating and cooking ... 115
Electric meters ... 117
Regulation and rates ... 120

GENERAL TABLES.

Table 117.—Commercial and municipal central electric stations—Comparative summary, by states and territories: 1907 and 1902. 126
Table 118.—Commercial and municipal central electric stations—Primary power and generating equipment, by states and territories: 1907 ... 130
Table 119.—Commercial and municipal central electric stations—Substation equipment, motors, transformers, meters, customers, and output of stations, by states and territories: 1907 ... 136
Table 120.—Commercial and municipal central electric stations—Analysis of service, by states and territories: 1907 ... 138
Table 121.—Commercial and municipal central electric stations—Analysis of supplies, materials, and fuel, by states and territories: 1907 ... 140
Table 122.—Commercial and municipal central electric stations—Analysis of income, by states and territories: 1907 ... 142
Table 123.—Commercial and municipal central electric stations—Number of salaried employees and total salaries, by states and territories: 1907 ... 143
Table 124.—Commercial and municipal central electric stations—Average number of wage-earners and total wages, by states and territories: 1907 ... 144
Table 125.—Commercial and municipal central electric stations—Analysis of miscellaneous expenses, by states and territories: 1907. 145
Table 126.—Commercial central electric stations—Primary power and generating equipment, by states and territories: 1907 ... 146
Table 127.—Commercial central electric stations—Substation equipment, motors, transformers, meters, customers, and output of stations, by states and territories: 1907 ... 152
Table 128.—Commercial central electric stations—Analysis of service, by states and territories: 1907 ... 154
Table 129.—Commercial central electric stations—Character of ownership, service, capitalization, and cost of construction and equipment, by states and territories: 1907 ... 156
Table 130.—Commercial central electric stations—Condensed statement: income and expenses, by states and territories: 1907 ... 158
Table 131.—Commercial central electric stations—Analysis of income, by states and territories: 1907 ... 159
Table 132.—Commercial central electric stations—Analysis of supplies, materials, and fuel, by states and territories: 1907 ... 160
Table 133.—Commercial central electric stations—Number of salaried employees and total salaries, by states and territories: 1907. 162
Table 134.—Commercial central electric stations—Average number of wage-earners and total wages, by states and territories: 1907. 163
Table 135.—Commercial central electric stations—Analysis of miscellaneous expenses, by states and territories: 1907 ... 164

Digitized by Google

Page.
Table 136.—Municipal central electric stations—Substation equipment, motors, transformers, meters, customers, and output of stations, by states and territories: 1907 ... 165
Table 137.—Municipal central electric stations—Primary power and generating equipment, by states and territories: 1907 ... 166
Table 138.—Municipal central electric stations—Analysis of service, by states and territories: 1907 ... 170
Table 139.—Municipal central electric stations—Character of service, bonds, and cost of construction and equipment, by states and territories: 1907 ... 172
Table 140.—Municipal central electric stations—Condensed statement: income and expenses, by states and territories: 1907 ... 173
Table 141.—Municipal central electric stations—Analysis of supplies, materials, and fuel, by states and territories: 1907 ... 174
Table 142.—Municipal central electric stations—Analysis of income, by states and territories: 1907 ... 176
Table 143.—Municipal central electric stations—Number of salaried employees and total salaries, by states and territories: 1907 ... 177
Table 144.—Municipal central electric stations—Average number of wage-earners and total wages, by states and territories: 1907 ... 178
Table 145.—Municipal central electric stations—Analysis of miscellaneous expenses, by states and territories: 1907 ... 179
Table 146.—Central electric light and power stations operated by street-railway companies—Analysis of arc-lighting service, by states: 1907 and 1902 ... 180
Table 147.—Central electric light and power stations operated by street-railway companies—Analysis of incandescent and other varieties of lighting service as well as motor service and number of meters, by states: 1907 and 1902 ... 181
Table 148.—Central electric light and power stations operated by street-railway companies—Income, by states: 1907 and 1902 ... 182

APPENDICES.

Appendix A.—Schedule ... 185–187
Appendix B.—Instructions to special agents ... 189–192

MAPS AND DIAGRAMS.

MAPS.

Map 1.—Geographic divisions ... 21
Map 2.—Central electric stations—Gross income: 1907 ... 77
Map 3.—Central electric stations—Gross income: 1902 ... 77

DIAGRAMS.

Diagram 1.—Central stations and electric railways, by character of primary power: 1907 ... 36
Diagram 2.—Central stations, by character of primary power: 1907 and 1902 ... 36
Diagram 3.—Central electric stations—Primary power, by states, arranged in order of their relative importance: 1907 and 1902 ... 37
Diagram 4.—Central electric stations—Steam and water power, by states, arranged in order of their relative importance: 1907 ... 40
Diagram 5.—Central electric stations—Capacity of dynamos: 1907 and 1902 ... 46
Diagram 6.—Central electric stations—Capacity of dynamos, by states, arranged in the order of their relative importance: 1907 and 1902 ... 48
Diagram 7.—Central electric stations—Output, by geographic divisions: 1907 and 1902 ... 51

ILLUSTRATIONS.

Facing page.
Interior view of Southern Power Company's hydro-electric plant ... 96
Horizontal low-pressure steam turbine and generator ... 96
Switchboard room, Quarry Street Station, Commonwealth Edison Co., Chicago ... 98
Steam turbine generating plant, Fisk Street Station, Commonwealth Edison Co., Chicago ... 98
1,500-kilowatt rotary converter ... 100
Generator connected to large gas engine, San Francisco ... 100
Conveying a 10,000-kilowatt, 100,000-volt transformer without case across the Feather River, California ... 102
Method of mounting distribution transformers on poles ... 102
400-ampere, 116 to 120 volt meter uncased to show mechanism ... 104
High-voltage transformer, Southern Power Company ... 104
Modern type of distribution transformer ... 104
Tungsten lighting, Riverside Drive, New York City ... 106
Inclosed arc-light lamp-posts, Fifth avenue, New York City ... 106
Arc lighting on Seventh avenue, New York City ... 108
Types of modern arc-light poles ... 108
Type of ordinary tungsten lamp ... 110
1,000-candlepower tungsten lamp compared with ordinary 16-candlepower carbon lamp ... 110
Inclosed arc lamp with ornamental casing for indoor service ... 110
Type of flaming-arc lamp ... 110
Room in New York Post-Office lighted with vacuum tubes ... 112
Typical electric chafing dish ... 116
Electric oil-tempering bath ... 116
Electric coffee percolator ... 116
Electric flatiron ... 116
Electric toaster with warming shelf ... 116
Section of switchboard, New York Edison System ... 120

Digitized by Google

LETTER OF TRANSMITTAL.

DEPARTMENT OF COMMERCE AND LABOR,
BUREAU OF THE CENSUS,
Washington, D. C., June 20, 1910.

SIR:

The act of Congress of June 7, 1906, amendatory of section 7 of the act approved March 6, 1902, provides that statistics concerning central electric light and power stations shall be collected by the Bureau of the Census at quinquennial periods.

I have the honor to submit herewith the first report prepared in conformity with the requirements of this law. The report presents statistics concerning the physical equipment, service, and financial operations of the central electric light and power stations. This is the second census of the central electric stations that has been taken since the Bureau of the Census was made a permanent office. The first census covered the year ending December 31, 1902, and was taken in accordance with the provisions of section 7 of the act of Congress of March 6, 1902.

In order to preserve the comparability of the data, the same form of schedule was used to collect statistics at both censuses, and, as nearly as possible, the same form of presenting the data has been followed in both reports. The statistics were collected and the report prepared under the supervision of Mr. William M. Steuart, chief statistician for manufactures. Mr. T. Commerford Martin, of New York City, was the consulting expert special agent of the office and prepared the portion of the report dealing with the technical features of the industry. Acknowledgment should also be made of the services of Mr. Frank L. Sanford, who prepared the analytical tables and verified the text.

Very respectfully,

E Dana Durand

Director of the Census.

Hon. CHARLES NAGEL,
Secretary of Commerce and Labor.

Digitized by Google

Digitized by Google

CENTRAL ELECTRIC LIGHT AND POWER STATIONS

Digitized by Google

Digitized by Google

CENTRAL ELECTRIC LIGHT AND POWER STATIONS.

CHAPTER I.

SCOPE AND GROUPING OF THE STATISTICS.

Central stations.—The act of Congress approved June 7, 1906, amending section 7 of the act establishing a permanent Census Office, authorizes the Director of the Census to collect every five years statistics relating to street railways, electric light and power, and the telephone and telegraph business. This report relates to central electric stations which furnish electrical energy for lighting and heating and power for manufacturing and mining purposes, for street railways and elevators, for charging batteries, etc. Central stations are classed as "commercial" and "municipal," the former being those operated by individuals, companies, and corporations; and the latter those operated by municipalities. The census takes no cognizance of electric stations that are operated by the Federal Government or of those operated primarily for the service of state institutions.

Central stations are further classed as "purely electric" and "composite." The central stations devoted solely to the generation and sale of electrical energy are designated as "purely electric." The majority of the central stations are of this class. Central stations engaged in the electric business and also in other industries, such as the manufacture of gas and the operation of waterworks, electric railways, ice plants, mining and other commercial enterprises, are designated as "composite." There is scarcely a limit to the variety of industries that are conducted under the same management with electric plants, such association of industries being the result of a belief that economy of administration is secured thereby. In many instances only one system of accounts is kept for all of the industries conducted under the same ownership, and this makes it difficult to obtain statistics which relate exclusively to the central electric light and power stations. When it was impossible to secure from book accounts exact data for the electric plants as distinct from other business, careful estimates as to the generation and sale of electric current were obtained.

No estimate could be made, however, in the case of the income and expenses that should be credited to the various phases of the business when steam was furnished for heating, or electric fixtures and supplies were sold in connection with the operation of the electric plant, and consequently the income and expenses pertaining to these transactions are included in those shown as incident to the operation of the station. Furthermore, it was often impracticable to apportion the capital among the various industries when other business was conducted in connection with the operation of the electric plant, and therefore the reported capital does not represent the amount actually chargeable to the electrical industry. The difficulty attending the segregation of capital is more fully explained in the chapter on capitalization, where an effort is made to show the capital properly chargeable to the central stations.

Municipal stations.—As already indicated, electric light and power plants operated under the ownership of municipalities and other local governments are considered as "central stations," and statistics for them are included in this report. These plants, generally established primarily to furnish current for lighting the public buildings, streets, and parks, frequently sell large quantities of electricity for commercial uses. Their field of operation is similar to that of the commercial stations, and their sources of revenue are much the same.

Although as a rule no cash income is derived from the furnishing of current for the use of the municipality, in order that the income shown in this report may represent the total consumption of electrical energy, the income for such energy furnished for municipal purposes has been estimated on the basis of what would have been paid for similar service if this service had been supplied by a commercial company in the vicinity.

The methods of conducting municipal plants, however, differ in so many important respects from those of the commercial plants that the statistics for the two classes of plants are presented separately.

Electric-railway plants and central electric stations.—The tendency to sell electricity for general commercial use is constantly increasing among electric-railway companies. It was impossible, however, in some instances, to obtain statistics concerning the capital, employees, expenses, etc., relating to the sale of electricity by railway companies for purposes similar to those reported by the central stations. As a rule but

Digitized by Google

one system of accounts is employed when the generating apparatus is used for the railway service and also for commercial light or power service, and is located in the same building and operated by the same primary power; in such cases it is impracticable to obtain separate financial statistics for the two branches of service. In all cases where separate data could be obtained, the statistics were included in the reports for the central stations and for the railways, respectively. If, however, separate returns could not be prepared, the statistics for the entire plant and equipment were included in the report on Street and Electric Railways, but certain features, such as the income from the sale of electrical energy, the number of lamps wired for service, the number of stationary motors, and the number of meters on consumption circuits, were so reported in the schedule as to enable their separate presentation, which will be found in Tables 146 to 148.

In 1902 there were 251 railway companies which furnished electricity for light, power, and other purposes. These companies reported an aggregate income of $7,703,574 from the sale of current. In 1907 there were 330 railway companies in this class, and the income from the sale of current amounted to $20,093,302. In 1902 the annual output of all electric stations and electric railways amounted to 4,768,535,512 kilowatt hours. In 1907 the output of the two classes of stations was 10,621,406,837 kilowatt hours, the increase in that year as compared with 1902 being 5,852,871,325 kilowatt hours, or 122.7 per cent. In 1902 the output by electric railways formed 47.4 per cent of the total, but by 1907 the proportion for such railways had decreased to 44.9 per cent. Because of consolidations of the two branches of the industry and the growing tendency of the railway companies to sell electricity for commercial purposes, the reports for the railway companies show an encroachment upon the field of the central stations, and the separate statistics for these latter stations are becoming less representative of the electrical energy sold for general commercial purposes. Nevertheless, the figures indicate that during the five years ending with 1907 the central stations increased more rapidly than the electric railways.

Isolated plants.—For the purpose of lighting and furnishing power for factories, hotels, or other enterprises, a large quantity of electricity is generated in plants which are operated for the exclusive benefit of their owners. Some of these plants sell limited amounts of current, but they were established as adjuncts to other forms of business, and practically no statistics concerning them are included in the census reports. Some of these isolated plants are extensive and have a much larger capacity than many of the central stations. At the census of 1902 it was estimated that there were 50,000 of these isolated electric plants in the United States. The number of commercial and municipal plants increased from 3,620 in 1902 to 4,714 in 1907, the increase amounting to 1,094, or 30.2 per cent. The application of the same rate of increase to the estimated number of isolated plants in 1902 gives an estimate of 65,000 for 1907. To what extent the utilization of surplus power in the operation of private electric plants to furnish light and power for large mills, department stores, hotels, and other industrial enterprises, has stimulated the increase in these plants it is impossible to state, and the above estimate, therefore, may be more or less than the actual number of isolated plants in existence.

Power or generating plants.—Census reports are prepared as far as possible in conformity with the systems of bookkeeping in use in the different establishments. Frequently two or more power or generating plants operated under the same management had but one system of accounts, and consequently it was necessary to include the statistics for all classed as a "central station" on the same census schedule. In the vast majority of cases only one power plant is operated under the same ownership, and the term "central station" of the census classification, therefore, generally represents one plant, but it is evident that the terms "central station" and "power or generating plant" are not synonymous. Although the statistics for a central station may represent a number of these plants, every effort was made to obtain separate census reports for the plants located in separate states, even if they were conducted under the same ownership.

The number of primary-power or generating plants was not called for in the schedule used for reporting central stations in 1907, but some idea of their number may be had from the fact that the returns showed 4,731 plants equipped with dynamos for the generation of electricity. Of the 4,714 stations reported in 1907, 227 had no generating equipment, while 113 had more than one power plant. This latter class reported 357 generating stations.

Period covered.—This census relates to the calendar year ending December 31, 1907. The only other complete enumeration of the central electric stations covered the twelve months ending June 30, 1902. At both censuses reports of the establishments were accepted for the business year which most nearly conformed to the census year, and all stations that were in operation during any portion of the respective census years were included. Therefore, although most of the reports were prepared for the census year, they do not necessarily represent the same period of twelve months, or even an entire year. In 1902 reports covering a period of less than a year were furnished by 141 commercial and 38 municipal stations, and in 1907, by 202 commercial and 49 municipal stations. The majority of the reports covering less than a year were for stations that commenced operations during the census year. Some reports of this kind, however, were for

Digitized by Google

properties that changed ownership during the year, the new owners being unable to furnish statistics for the operations conducted under the previous ownership. These variations in the period covered by the reports necessarily have some influence on certain statistics, such as the output of stations. As a rule, however, the reports covering less than a year are for comparatively small plants, and the statistics for such plants have but little effect upon the various totals. The census takes no cognizance of stations that had not begun operations prior to the close of the census year, except that limited statistics are presented in Chapter VI, pages 74 and 75, for such stations as were under construction during the year.

Basis of canvass.—In the endeavor to secure statistics from all central stations lists of the names and addresses of such concerns were prepared from information obtained from the postmasters in the different cities and towns and from directories and other sources of information. These lists formed the basis of the canvass. The United States was divided into districts and each district given to one or more agents, who were instructed not only to secure reports from all stations named on the lists, but to make careful inquiry for other stations. It is believed that in this way a thorough canvass was made of the entire country and reports were secured from all plants that should be classed as "central stations."

Grouping of statistics.—Tables 118 to 145 contain all of the detailed statistics that were collected for 1907 for the central stations in each state and territory. In other tables and text statements the statistics have been grouped under appropriate headings, and comparisons made, when possible, with the data for 1902. The most important classifications of the statistics are the following:

1. Commercial central stations, or those that were operated under private ownership, whether by individuals, companies, or corporations.

2. Municipal central stations, or those that were operated by state, city, or other local governments, except those operated specially for institutions.

3. Purely electric central stations, or those that do a strictly electrical business.

4. Composite central stations, or those operated in connection with some other industry.

5. Central stations according to dynamo capacity.

6. Central stations operated by water power exclusively.

7. Central stations operated by steam power exclusively.

8. Central stations operated by both steam and water power.

9. Central stations in selected cities where all or practically all of the current is produced and consumed within the incorporated limits of the cities.

This grouping of the statistics closely follows the arrangement established at the census of 1902, in order that comparisons may be made to show the development of the industry.

The report of 1902 shows the number of central stations that commenced operations each year from 1881 to 1902, but this feature was abandoned at the census of 1907 because changes in ownership are so frequent that in many instances it is impossible to obtain the date on which operations were commenced.

The ease and practicability of long-transmission lines has caused a great extension of the area which may be covered by lines from a central station, and therefore it often happens that the generating station is located at a place which from the standpoint of population is comparatively insignificant, whereas the places at which the electrical energy is delivered for use may be of considerable size. On the other hand, many stations located in large cities are extending their service into the surrounding territory. For these reasons, a classification of central (generating) stations by the population of the places in which these stations are located would not convey a correct idea of the population served, or available for service, and consequently this presentation also, which was shown in 1902, has been abandoned.

The meager statistics concerning electric stations collected at the census of 1890 are not presented in this report because they are so fragmentary that they are not fairly comparable with those for subsequent censuses.

25142—10——2

Digitized by Google

CHAPTER II.

SUMMARY OF STATISTICS.

The magnitude of the central electric station industry in the census years 1902 and 1907, and the growth during the five-year period, are shown in Table 1.

TABLE 1.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS: 1907 AND 1902.

	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Number of stations	4,714	3,620	3,462	2,805	1,252	815	30.2	23.4	53.6
Cost of construction and equipment	$1,090,913,622	$504,740,352	$1,054,034,175	$482,719,879	$42,879,447	$22,020,473	117.3	118.4	94.7
Gross income	$175,642,338	$85,700,605	$161,630,339	$78,735,500	[1] $14,011,999	[1] $6,965,105	104.9	105.3	101.2
Electric service	$169,614,691	$84,186,605	$156,000,257	$77,349,749	[1] $13,614,434	[1] $6,836,856	101.5	101.7	99.1
Lighting	$125,755,114	$70,138,147	$112,714,851	$63,389,284	$13,040,263	$6,748,863	79.3	77.8	93.2
Stationary motors	$28,511,550	$9,910,217	$27,995,177	$9,839,677	$516,373	$70,540	187.7	184.5	632.0
All other	$15,348,027	$4,138,241	$15,290,229	$4,120,788	$57,798	$17,453	270.9	271.1	231.2
All other sources	$6,027,647	$1,514,000	$5,630,082	$1,385,751	$397,565	$128,249	298.1	306.3	210.0
Total expenses	$106,205,149	$55,457,830	$97,037,961	$50,716,648	$9,167,188	$4,741,182	91.5	91.3	93.4
Cost of supplies and materials, including power purchased	$21,400,823	$11,280,423	$19,665,919	$10,303,956	$1,734,904	$976,467	89.7	90.9	77.6
Cost of fuel	$23,057,745	$11,635,509	$19,824,962	$10,189,685	$3,232,783	$1,445,824	98.2	94.6	123.6
Miscellaneous expenses	$26,326,257	$11,895,206	$25,611,771	$11,456,037	$714,486	$439,169	121.3	123.6	62.7
Salaries and wages	$35,420,324	$20,646,692	$31,935,309	$18,766,970	$3,485,015	$1,879,722	71.6	70.2	85.4
Salaried officials, clerks, etc.—									
Number	12,990	6,996	11,375	6,046	1,615	950	85.7	88.1	70.0
Salaries	$11,733,787	$5,663,580	$10,738,955	$5,206,199	$994,832	$457,381	107.2	106.3	117.5
Wage-earners—									
Average number	34,642	23,330	30,691	20,863	3,951	2,467	48.5	47.1	60.2
Wages	$23,686,537	$14,983,112	$21,196,354	$13,560,771	$2,490,183	$1,422,341	58.1	56.3	75.1
Primary power:[2]									
Number of machines	10,150	7,485	8,205	6,325	1,945	1,160	35.6	29.7	67.7
Horsepower capacity	4,032,365	1,830,594	3,712,518	1,671,401	319,847	159,193	120.3	122.1	100.9
Steam engines and steam turbines—									
Number	7,206	5,930	5,492	4,870	1,714	1,060	21.5	12.8	61.7
Horsepower	2,627,450	1,379,941	2,344,032	1,232,923	283,418	147,018	90.4	90.1	92.8
Gas engines—									
Number	463	165	385	147	78	18	180.6	161.9	333.3
Horsepower	55,828	12,181	49,746	11,224	6,082	957	358.3	343.2	535.5
Water wheels—									
Number	2,481	1,390	2,328	1,308	153	82	78.5	78.0	86.6
Horsepower	1,349,087	438,472	1,318,740	427,254	30,347	11,218	207.7	208.7	170.5
Generating equipment:									
Dynamos—									
Number	12,173	12,484	9,778	10,662	2,395	1,822	[3] 2.5	[3] 8.3	31.4
Kilowatt capacity	2,709,225	1,212,235	2,500,209	1,098,855	209,016	113,380	123.5	127.5	84.3
Direct-current, constant-voltage—									
Number	3,680	3,823	3,169	3,405	511	418	[3] 3.7	[3] 6.9	22.2
Kilowatt capacity	406,460	330,065	379,706	312,509	26,754	17,556	23.1	21.5	52.4
Direct-current, constant-amperage—									
Number	1,685	3,539	1,246	2,957	439	582	[3] 52.4	[3] 57.9	[3] 24.6
Kilowatt capacity	80,992	145,866	61,753	117,695	19,239	28,171	[3] 44.5	[3] 47.5	[3] 31.7
Alternating single-phase and polyphase current—									
Number	6,808	5,122	5,303	4,300	1,445	822	32.9	24.7	75.8
Kilowatt capacity	2,221,773	736,304	2,058,750	668,651	163,023	67,653	201.7	207.9	141.0
Output of stations, kilowatt hours	5,862,276,737	2,507,051,115	5,572,813,949	2,311,146,676	289,462,788	195,904,439	133.8	141.1	47.8
Lamps wired for service:[4]									
Arc	555,713	385,698	472,773	334,903	82,940	50,795	44.1	41.2	63.3
Incandescent[5]	41,445,997	18,194,044	37,393,549	16,616,593	4,052,448	1,577,451	127.8	125.0	156.9
Other varieties—Nernst, vacuum, vapor, etc	162,338	[6]	153,468	[6]	8,870	[6]	.....	.....	.....

[1] Includes the estimated income for current consumed in municipal buildings and in lighting streets, parks, etc.
[2] Exclusive of auxiliary engines with a total capacity of 65,823 horsepower in 1907 and 14,454 horsepower in 1902.
[3] Decrease.
[4] Exclusive of 275,079 lamps used by the central stations to light their own electric properties in 1907. These lamps were not reported separately in 1902.
[5] The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.
[6] Not reported separately.

As previously explained, the figures for the central stations do not represent the entire production of electrical energy. To arrive at the aggregate it would be necessary to consider also the electric railways, telephone and telegraph lines, electric police-patrol and fire-alarm systems, and the isolated electric plants.

In 1907, exclusive of the isolated electric plants, there were upward of 30,000 individuals, companies, corporations, and municipalities which reported the generation or utilization of electric current in what may be termed "commercial enterprises." These industries represent an outstanding capitalization of $6,209,746,753, of which $1,367,338,836 is credited to central electric stations, $3,774,772,096 to electric railways, $814,616,004 to commercial or mutual telephone companies, and $253,019,817 to telegraph companies, the latter item including $32,726,242, the capital stock of wireless-telegraph companies. The capitalization of

Digitized by Google

the 17,702 independent farmer or rural telephone lines and of the 1,157 electric police-patrol and fire-alarm systems could not be ascertained. In addition, there were a number of companies organized for the purpose of acquiring the capital stock or bonds of electric companies, street railways, gas and water systems, and similar properties, holding the same for investment and to some extent supervising the operation of the underlying companies. To show the capitalization of these holding companies would be misleading as applied to central electric stations, since it would be impossible to determine the extent of its application to the electrical industry as distinguished from others. In view of this condition and because of the difficulty of securing the information, it was deemed advisable to omit the data as relating to central stations.

In view of the very large increases shown for the details of the industry as a whole, it seems necessary to state that the loss shown in the number and the capacity of the direct-current machines was due to the fact that this type of dynamo has been superseded by the alternating single-phase and polyphase current machine.

Although central-station statistics of the comparatively few street railways that sold current and that were able to prepare complete separate reports have been included with those for central electric stations, in order that that branch of the electrical industry might be shown as fully as possible, the full measure of growth of central-station work does not appear in Table 1 because of the fact that this service is also largely carried on by numerous street-railway companies which combine the central-station business so closely with other activities as not to permit of complete separate reports. Detailed statistics for the electric-railway companies which were unable to make separate reports will be found in Tables 146, 147, and 148, and a brief summary of the same is presented in Table 2.

TABLE 2.—*Central electric stations operated by street-railway companies: 1907 and 1902.*

[Complete separate reports for these stations could not be secured, hence the full statistics for them have been included with those for electric railways. This table does not include central stations operated by street-railway companies which furnished complete separate reports.]

	1907	1902	Per cent of increase.
Number of stations	177	118	50.0
Gross income	$17,291,824	$6,469,726	167.3
Electric service	$16,576,555	$6,271,815	164.3
Lighting	$13,273,295	$5,492,669	141.7
Stationary motors	$2,685,013	$768,040	249.6
All other	$618,247	$11,106	5,466.8
All other sources	$715,269	$197,911	261.4
Lamps wired for service:			
Arc	80,102	33,863	136.5
Incandescent[1]	4,545,839	1,442,685	215.1
Other varieties—Nernst, vacuum, vapor, etc	28,641	(2)	.....
Stationary motors:			
Number	20,468	10,049	103.7
Horsepower	158,923	35,688	345.3
Meters on consumption circuits, number	213,886	56,601	277.9

[1] The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.
[2] Not reported separately.

Table 2 shows that while the number of stations which were unable to make separate reports is growing, there is still greater increase in their importance. The increase in the income for electric service, $10,822,098, does not fully represent this feature of the electric service, since, as shown in the report on street railways, 330 companies reported the sale of electric current during 1907, and the income from this source amounted to $20,093,302. Some of the current was sold to other electric railways, but a large portion was used for light and power in enterprises not connected with the railways. However, statistics of income and equipment can be shown separately for only 177 companies. The increases in number of lamps, number and horsepower of stationary motors, and number of meters on consumption circuits, not only show the rapid growth of central-station work in connection with the operation of street railways, but demonstrate the wonderful facility with which electrical energy may be utilized wherever there is a demand for light or power.

Ownership of central electric stations.—Table 3 shows the number of commercial central stations conducted under the different forms of ownership.

TABLE 3.—*Commercial central electric stations—Number, by character of ownership: 1907 and 1902.*

CHARACTER OF OWNERSHIP.	1907	1902	Per cent of increase.	PER CENT DISTRIBUTION.	
				1907	1902
Total	3,462	2,805	23.4	100.0	100.0
Individual	609	528	15.3	17.6	18.8
Firm	298	228	30.7	8.6	8.1
Incorporated company	[1] 2,555	2,049	24.7	73.8	73.1

[1] Includes 2 stations classed as "Other forms of ownership," in order that the operations of individual stations may not be disclosed.

Although the number of stations operated by the several forms of ownership can not properly be used to determine their relative importance, it shows the character of ownership which predominates and which seems to be one of the distinctive features of the industry. Nearly three-fourths of the stations reported at each census were operated by incorporated companies. Individual ownership was next in importance as to number of stations, with less than one-fifth of the total at each census. The percentage which stations under individual ownership represent of the total number for all classes decreased from 18.8 in 1902 to 17.6 in 1907, a loss of 1.2. Firms showed but little proportionate change, having less than 9 per cent of the total number at each census. Detailed statistics for 1907 for the different forms of ownership are presented in Table 4. These statistics are confined to 1907 because in 1902 data as to character of ownership were limited to the number of establishments.

Digitized by Google

TABLE 4.—COMMERCIAL CENTRAL ELECTRIC STATIONS, BY CHARACTER OF OWNERSHIP: 1907.

	CHARACTER OF OWNERSHIP.			
	Total.	Individual.	Firm.	Incorporated company. [1]
Number of stations	3,462	609	298	2,555
Cost of construction and equipment	$1,054,034,175	$6,574,920	$4,019,813	$1,043,439,442
Gross income	$161,630,339	$2,371,467	$1,478,134	$157,780,738
Electric service	$156,000,257	$2,262,102	$1,408,139	$152,330,016
Lighting	$112,714,851	$2,130,822	$1,273,793	$109,310,236
Stationary motors	$27,995,177	$80,528	$96,801	$27,817,848
All other	$15,290,229	$50,752	$37,545	$15,201,932
All other sources	$5,630,082	$109,365	$69,995	$5,450,722
Total expenses	$97,037,961	$1,615,426	$1,021,788	$94,400,747
Cost of supplies and materials	$12,969,731	$231,471	$175,456	$12,562,804
Cost of fuel	$19,824,962	$560,453	$317,946	$18,946,563
Power purchased	$6,696,188	$58,157	$40,590	$6,597,441
Miscellaneous expenses	$25,611,771	$206,510	$119,562	$25,285,699
Salaries and wages	$31,935,309	$558,835	$368,234	$31,008,240
Salaried officials, clerks, etc.—				
Number	11,375	171	139	11,065
Salaries	$10,738,955	$112,665	$89,614	$10,536,676
Wage-earners—				
Average number	30,691	863	495	29,333
Wages	$21,196,354	$446,170	$278,620	$20,471,564
Primary power:				
Number of machines	8,981	847	436	7,698
Horsepower capacity	3,776,837	74,668	47,025	3,655,144
Steam engines—				
Number	5,144	520	285	4,339
Horsepower	1,546,007	50,662	30,034	1,465,311
Steam turbines—				
Number	348	1	.....	347
Horsepower	798,025	30	.....	797,995
Gas engines—				
Number	385	83	37	265
Horsepower	49,746	3,577	1,399	44,770
Water wheels—				
Number	2,328	209	103	2,016
Horsepower	1,318,740	18,751	14,957	1,285,032
Auxiliary engines—				
Number	776	34	11	731
Horsepower	64,319	1,648	635	62,036
Generating equipment:				
Dynamos—				
Number	9,778	839	412	8,527
Kilowatt capacity	2,500,209	44,315	28,511	2,427,383
Direct-current, constant-voltage—				
Number	3,169	403	193	2,573
Kilowatt capacity	379,706	15,365	6,981	357,360
Direct-current, constant-amperage—				
Number	1,246	39	17	1,190
Kilowatt capacity	61,753	1,014	407	60,332
Alternating single-phase and polyphase current—				
Number	5,363	397	202	4,764
Kilowatt capacity	2,058,750	27,936	21,123	2,009,691
Output of stations, kilowatt hours	5,572,813,949	43,103,493	41,357,746	5,488,352,710
Lamps wired for service: [2]				
Arc	472,773	5,758	3,021	463,994
Incandescent [3]	37,393,549	736,594	406,116	36,250,839
Other varieties—Nernst, vacuum, vapor, etc	153,468	625	355	152,488

[1] Includes 2 stations classed as "Other forms of ownership" in order that the operations of individual stations may not be disclosed.
[2] Exclusive of 275,079 lamps used by the central stations to light their own electric properties.
[3] The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.

The statistics in Table 4 show the great preponderance of corporate ownership. The proportions contributed by the corporations to several of the chief totals of the table were as follows: Cost of construction and equipment, 99 per cent; income from sale of current, 97.6 per cent; primary horsepower, 96.8 per cent; kilowatt capacity of dynamos, 97.1 per cent; output of stations, 98.5 per cent; number of arc lamps, 98.1 per cent; and number of incandescent lamps, 96.9 per cent. If the municipal stations were included, the proportions for incorporated companies would be less, but they would still represent about 90 per cent of the several totals, while of the remaining 10 per cent, roughly speaking, about 2 per cent may be assigned to individuals and firms, with individual ownership having somewhat the larger share, and 8 per cent to municipalities.

As already stated, central stations may be divided into the purely electric, those which were operated solely as electrical enterprises; and the composite, those which were operated in connection with some other industry or service, such as waterworks, gas plants, etc. Table 5 gives detailed statistics of these two classes of stations subdivided by character of ownership.

A comparison of the totals for the two groups of stations shows that about three-fifths of the income and cost of construction and equipment was connected with the purely electric and two-fifths with the composite stations. Nearly two-thirds of the commercial central stations were reported as purely electric, and something more than one-third as composite. This division of commercial stations may also be accepted as roughly representing the respective importance of the purely electric and the composite stations. While the proportions for the chief items for the commercial stations are thus decidedly greater in the purely electric than in the composite class, this does not hold true for the municipal stations, where such important totals as income, expenses, horsepower of primary-

Digitized by Google

power plant, kilowatt capacity of dynamos, and number of incandescent lamps are greater for the composite stations. The fact that such public utilities as water and gas are so often operated by municipalities which also operate electric stations explains this condition. Nearly four-fifths of the purely electric central stations and more than three-fifths of those in the composite group were commercial stations. Exclusive of the item of arc lamps, about 6 per cent of the income and equipment of the purely electric group was reported by the municipal stations, as compared with about 10 per cent for these stations in the composite group.

TABLE 5.—PURELY ELECTRIC AND COMPOSITE CENTRAL ELECTRIC STATIONS, BY CHARACTER OF OWNERSHIP: 1907.

	Total.	PURELY ELECTRIC STATIONS.				COMPOSITE STATIONS.			
		Commercial.			Municipal.	Commercial.			Municipal.
		Individual.	Firm.	Incorporated company.[1]		Individual.	Firm.	Incorporated company.	
Number of stations	4,714	397	175	1,555	521	212	123	1,000	731
Cost of construction and equipment	$1,096,913,622	$4,427,517	$2,291,942	$632,717,815	$23,489,640	$2,147,403	$1,727,871	$410,721,627	$19,389,807
Gross income	$175,642,338	$1,606,500	$863,938	$98,751,829	$6,752,654	$764,967	$614,196	$59,028,909	$7,259,345
Electric service	$169,614,691	$1,538,157	$813,222	$95,705,459	$6,572,736	$723,945	$594,917	$56,624,557	$7,041,698
Lighting	$125,755,114	$1,442,855	$751,275	$67,189,245	$6,294,677	$687,967	$522,518	$42,120,991	$6,745,586
Stationary motors	$28,511,550	$63,834	$35,121	$17,852,985	$261,061	$16,694	$61,680	$9,964,863	$255,312
All other	$15,348,027	$31,468	$26,826	$10,663,229	$16,998	$19,284	$10,719	$4,538,703	$40,800
All other sources	$6,027,647	$68,343	$50,716	$3,046,370	$179,918	$41,022	$19,279	$2,404,352	$217,647
Total expenses	$106,205,149	$1,078,567	$580,033	$57,456,650	$4,374,925	$536,859	$441,755	$36,944,097	$4,792,263
Cost of supplies and materials	$14,326,351	$155,112	$96,035	$7,360,405	$678,961	$76,359	$79,421	$5,202,399	$677,659
Cost of fuel	$23,057,745	$374,037	$185,345	$10,592,454	$1,324,732	$186,416	$132,601	$8,354,109	$1,908,051
Power purchased	$7,074,472	$56,278	$27,237	$4,598,100	$277,904	$1,879	$13,353	$1,999,341	$100,380
Miscellaneous expenses	$26,326,257	$137,143	$65,721	$16,314,907	$331,600	$69,367	$53,841	$8,970,792	$382,896
Salaries and wages	$35,420,324	$355,997	$205,695	$18,590,784	$1,761,728	$202,838	$162,539	$12,417,456	$1,723,287
Salaried officials, clerks, etc.—									
Number	12,990	100	78	6,469	615	71	61	4,596	1,000
Salaries	$11,733,787	$65,261	$50,325	$6,438,363	$406,875	$47,404	$39,289	$4,098,313	$587,957
Wage-earners—									
Average number	34,642	555	272	17,494	1,941	308	223	11,839	2,010
Wages	$23,686,537	$290,736	$155,370	$12,152,421	$1,354,853	$155,434	$123,250	$8,319,143	$1,135,330
Primary power:									
Number of machines	10,998	532	242	4,446	819	315	194	3,252	1,198
Horsepower capacity	4,098,188	48,370	25,440	2,250,483	149,018	26,296	21,585	1,404,661	172,333
Steam engines—									
Number	6,829	339	160	2,343	657	181	125	1,996	1,028
Horsepower	1,810,040	34,082	16,820	785,663	113,729	16,580	13,214	679,648	150,304
Steam turbines—									
Number	377	.....	.....	181	11	1	.....	166	18
Horsepower	817,410	.....	.....	596,712	10,150	30	.....	201,283	9,235
Gas engines—									
Number	463	66	30	166	33	17	7	99	45
Horsepower	55,828	2,867	1,049	18,736	2,796	710	350	26,034	3,286
Water wheels—									
Number	2,481	104	44	1,343	84	105	59	673	69
Horsepower	1,349,087	10,535	7,326	824,211	21,813	8,216	7,631	460,821	8,534
Auxiliary engines—									
Number	848	23	8	413	34	11	3	318	38
Horsepower	65,823	886	245	25,161	530	762	390	36,875	974
Generating equipment:									
Dynamos—									
Number	12,173	556	251	4,878	1,064	283	161	3,649	1,331
Kilowatt capacity	2,709,225	29,620	16,477	1,528,189	96,528	14,695	12,034	899,194	112,488
Direct-current, constant-voltage—									
Number	3,680	257	121	1,409	228	146	72	1,164	283
Kilowatt capacity	406,460	10,357	4,370	196,380	11,360	5,008	2,611	160,980	15,394
Direct-current, constant-amperage—									
Number	1,685	34	12	732	266	5	5	458	173
Kilowatt capacity	80,992	919	304	38,040	12,241	95	103	22,292	6,998
Alternating, single-phase and polyphase current—									
Number	6,808	265	118	2,737	570	132	84	2,027	875
Kilowatt capacity	2,221,773	18,344	11,803	1,293,769	72,927	9,592	9,320	715,922	90,096
Output of stations, kilowatt hours	5,862,276,737	27,704,477	15,193,414	3,692,080,449	145,109,547	15,399,016	26,164,332	1,796,272,261	144,353,241
Lamps wired for service:[2]									
Arc	555,713	4,055	1,924	280,101	48,206	1,703	1,097	183,893	34,734
Incandescent[3]	41,445,997	522,444	245,456	21,852,656	1,710,564	214,150	160,660	14,398,183	2,341,884
Other varieties—Nernst vacuum, vapor, etc	162,338	447	262	112,069	5,575	178	93	40,419	3,295

[1] Includes 2 stations classed as "Other forms of ownership," in order that the operations of individual stations may not be disclosed.
[2] Exclusive of 275,079 lamps used by the central stations to light their own electric properties.
[3] The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.

Table 6 presents a comparative summary of the purely electric and the composite plants for 1907 and 1902.

The percentages of increase for the composite stations are much greater than for the purely electric, but the absolute increases show no such excess. On the contrary, the purely electric stations show a greater absolute increase for all the leading items. It is noteworthy that both the commercial and the municipal stations share in the uniformly larger percentages of increase for the composite stations, which appears to indicate that the distinctive characteristics of the two classes of stations are much less marked than formerly.

Digitized by Google

TABLE 6.—PURELY ELECTRIC AND COMPOSITE CENTRAL ELECTRIC STATIONS—COMMERCIAL AND MUNICIPAL: 1907 AND 1902.

	Census.	Aggregate.	PURELY ELECTRIC STATIONS.			COMPOSITE STATIONS.		
			Total.	Commercial.	Municipal.	Total.	Commercial.	Municipal.
Number of stations	1907	4,714	2,648	2,127	521	2,066	1,335	731
	1902	3,620	2,139	1,759	380	1,481	1,046	435
Per cent of increase		30.2	23.8	20.9	37.1	39.5	27.6	68.0
Cost of construction and equipment	1907	$1,096,913,622	$662,926,914	$639,437,274	$23,489,640	$433,986,708	$414,596,901	$19,389,807
	1902	$504,740,352	$334,151,724	$320,580,333	$13,571,391	$170,588,628	$162,139,546	$8,449,082
Per cent of increase		117.3	98.4	99.5	73.1	154.4	155.7	129.5
Gross income	1907	$175,642,338	$107,974,921	$101,222,267	$6,752,654	$67,667,417	$60,408,072	$7,259,345
	1902	$85,700,605	$58,603,406	$54,455,737	$4,147,669	$27,097,199	$24,279,763	$2,817,436
Per cent of increase		104.9	84.2	85.9	62.8	149.7	107.6	157.7
Electric service	1907	$169,614,691	$104,629,574	$98,056,838	$6,572,736	$64,985,117	$57,943,419	$7,041,698
	1902	$84,186,605	$57,470,597	$53,394,158	$4,076,439	$26,716,008	$23,955,591	$2,760,417
Per cent of increase		101.5	82.1	83.6	61.2	143.2	141.9	155.1
All other sources	1907	$6,027,647	$3,345,347	$3,165,429	$179,918	$2,682,300	$2,464,653	$217,647
	1902	$1,514,000	$1,132,809	$1,061,579	$71,230	$381,191	$324,172	$57,019
Per cent of increase		298.1	195.3	198.2	152.6	603.7	660.3	281.7
Total expenses	1907	$106,205,149	$63,490,175	$59,115,250	$4,374,925	$42,714,974	$37,922,711	$4,792,263
	1902	$55,457,830	$37,272,578	$34,525,512	$2,747,066	$18,185,252	$16,191,136	$1,994,116
Per cent of increase		91.5	70.3	71.2	59.3	134.9	134.2	140.3
Primary power:[1]								
Number of machines	1907	10,150	5,561	4,776	785	4,589	3,429	1,160
	1902	7,485	4,615	4,032	583	2,870	2,293	577
Per cent of increase		35.6	20.5	18.5	34.7	59.9	49.5	101.0
Horsepower capacity	1907	4,032,365	2,446,489	2,298,001	148,488	1,585,876	1,414,517	171,359
	1902	1,830,594	1,242,362	1,151,520	90,842	588,232	519,881	68,351
Per cent of increase		120.3	96.9	99.6	63.5	169.6	172.1	150.7
Generating equipment:								
Dynamos—								
Number	1907	12,173	6,749	5,685	1,064	5,424	4,093	1,331
	1902	12,484	7,752	6,783	969	4,732	3,879	853
Per cent of increase		[2] 2.5	[2] 12.9	[2] 16.2	9.8	14.6	5.5	56.0
Kilowatt capacity	1907	2,709,225	1,670,814	1,574,286	96,528	1,038,411	925,923	112,488
	1902	1,212,235	818,905	753,021	65,784	393,430	345,834	47,596
Per cent of increase		123.5	104.1	109.1	46.7	163.9	167.7	136.3
Output of stations, kilowatt hours	1907	5,962,276,737	3,890,087,897	3,734,978,340	145,109,547	1,982,188,850	1,837,835,609	144,353,241
	1902	2,507,051,115	1,836,748,836	1,716,909,602	119,839,234	670,302,279	594,237,074	76,065,205
Per cent of increase		133.8	111.2	117.5	21.1	195.7	209.3	89.8
Lamps wired for service:[3]								
Arc	1907	555,713	334,286	286,080	48,206	221,427	186,693	34,734
	1902	385,698	252,407	219,409	32,998	133,291	115,494	17,797
Per cent of increase		44.1	32.4	30.4	46.1	66.1	61.6	95.2
Incandescent[4]	1907	41,445,997	24,331,120	22,620,556	1,710,564	17,114,877	14,772,993	2,341,884
	1902	18,194,044	12,248,918	11,463,050	785,868	5,945,126	5,153,543	791,583
Per cent of increase		127.8	98.6	97.3	117.7	187.9	186.7	195.8
Other varieties—Nernst, vacuum, vapor, etc.[5]	1907	162,338	118,353	112,778	5,575	43,985	40,690	3,295

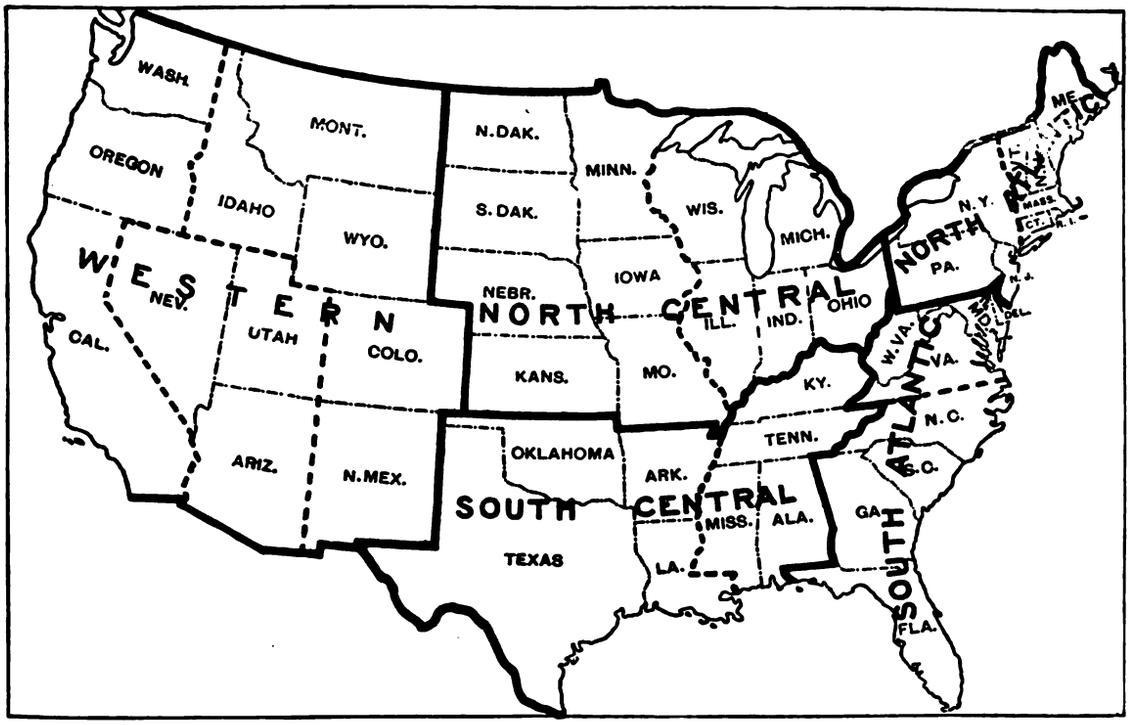
[1] Exclusive of auxiliary engines with a total capacity of 65,823 horsepower in 1907 and 14,454 horsepower in 1902.
[2] Decrease.
[3] Exclusive of 275,079 lamps used by the central stations to light their own electric properties in 1907. These lamps were not reported separately in 1902.
[4] The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.
[5] Not reported separately in 1902.

Relationship of population and central stations.—As a rule, the central electric stations are concentrated in the most populous states and at points within these states from which the largest percentage of the population can be served economically. From Table 119 it appears that New York, Pennsylvania, Illinois, and Ohio, the 4 states having the largest population, containing together 29.6 per cent of the total for the United States, reported 1,296 electric stations, or 27.5 per cent of the total number in operation during 1907, and the annual output of these stations amounted to 2,553,745,890 kilowatt hours, or 43.6 per cent of the output of all stations in the United States. While the proportionate number of central stations and the proportionate population of this group of states were very nearly the same, or less than one-third of the total, their proportion of the kilowatt-hour output formed nearly one-half of the total. In 1902 the exact percentages for these items were as follows: Population, 29.7 per cent; number of establishments, 30.8 per cent; and kilowatt-hour output, 49.1 per cent.

A number of the tables contained in this report present the statistics by the officially adopted geographic divisions. An outline and a list follow, showing the states and territories contained in each division:

Digitized by Google

MAP 1.—GEOGRAPHIC DIVISIONS.



North Atlantic division:
- Maine.
- New Hampshire.
- Vermont.
- Massachusetts.
- Rhode Island.
- Connecticut.
- New York.
- New Jersey.
- Pennsylvania.

South Atlantic division:
- Delaware.
- Maryland.
- District of Columbia.
- Virginia.
- West Virginia.
- North Carolina.
- South Carolina.
- Georgia.
- Florida.

North Central division:
- Ohio.
- Indiana.
- Illinois.
- Michigan.
- Wisconsin.
- Minnesota.
- Iowa.
- Missouri.
- North Dakota.
- South Dakota.
- Nebraska.
- Kansas.

South Central division:
- Kentucky.
- Tennessee.
- Alabama.
- Mississippi.
- Louisiana.
- Arkansas.
- Oklahoma.
- Texas.

Western division:
- Montana.
- Idaho.
- Wyoming.
- Colorado.
- New Mexico.
- Arizona.
- Utah.
- Nevada.
- Washington.
- Oregon.
- California.

The largest proportion of the total population of the country, 33.9 per cent in 1907 and 34.5 per cent in 1902, was in the North Central states. These states also contained nearly the same percentage of electric lamps wired for service, but for the horsepower of primary-power plants, kilowatt capacity of dynamos, and output of stations, the percentages were considerably less. The North Atlantic states were next in the proportion of population, with 27.8 per cent in 1907 and 27.7 per cent in 1902, but their proportions for the various items of the central-station industry for both 1907 and 1902 were much larger, as follows: Horsepower of primary-power plant, 37.4 and 44.2 per cent, respectively; kilowatt capacity of dynamos, 38.9 and 42.7 per cent; output of stations, 42.4 and 50.6 per cent; number of arc lamps, 43.6 and 44 per cent; and number of incandescent lamps, 41.5 and 47.1 per cent.

The South Atlantic and South Central divisions, treated as a single group, embraced 32.7 per cent of the population in 1907 and 32.4 per cent in 1902. Although their proportions of the various items of the central-station industry were larger in 1907 than in 1902, they were the smallest shown for any section of the country. The exact percentages for each of these two divisions for 1907 and 1902 were as follows: South Atlantic, population, 13.5 and 13.7 per cent, respectively; horsepower of primary-power plant, 7.2 and 5 per cent; kilowatt capacity of dynamos, 7.2 and 5.1 per cent; output of stations, 4.5 and 4.1 per cent; number of arc lamps, 4.9 and 4.5 per cent; and number of incandescent lamps, 4.6 and 3.4 per cent. The South Central, population, 19.1 and 18.6 per cent; horsepower of primary-power plant, 6 and 6.4 per cent; kilowatt capacity of dynamos, 6.1 and 6.8 per cent; output of stations, 4.4 and 6.1 per cent; number of arc lamps, 7.2 and 6 per cent; and number of incandescent lamps, 6.5 and 5.6 per cent. The Western division was the smallest in population, with 5.6 per cent of the total in 1907 and 5.5 per cent in 1902. Its percentages of the various items for the central-station industry for 1907 and 1902, respectively, were as follows: Horsepower of primary-power plant, 19.6 and 15.2 per cent; kilowatt capacity of dynamos, 18 and 14.4 per cent; output of stations, 23.8 and 13.4 per cent; number of arc lamps, 7.6 and 7.8 per cent; and number of incandescent lamps, 13 and 10 per cent.

Digitized by Google

TABLE 7.—CENTRAL ELECTRIC STATIONS—RELATION OF LEADING ITEMS TO POPULATION, BY GEOGRAPHIC DIVISIONS: 1907 AND 1902.

DIVISION.	Census.	Population.[1]	NUMBER OF STATIONS.			HORSEPOWER OF ENGINES AND WATER WHEELS.[2]		KILOWATT CAPACITY OF DYNAMOS.		OUTPUT OF STATIONS, KILOWATT HOURS.		LAMPS.[3]			
												Arc.		Incandescent.[4]	
			Total.	Commercial.	Municipal.	Amount.	Per 1,000 population.	Amount.	Per 1,000 population.	Amount.	Per 1,000 population.	Number.	Per 1,000 population.	Number.	Per 1,000 population.
United States	1907	85,532,761	4,714	3,462	1,252	4,098,188	47.91	2,709,225	31.67	5,862,276,737	68,538.38	555,713	6.50	41,445,997	484.56
	1902	78,576,436	3,620	2,805	815	1,845,048	23.48	1,212,235	15.43	2,507,051,115	31,905.89	385,698	4.91	18,194,044	231.55
Per cent of increase		8.9	30.2	23.4	53.6	122.1		123.5		133.8		44.1		127.8	
North Atlantic	1907	23,779,013	1,070	920	150	1,534,586	64.54	1,054,528	44.35	2,483,106,227	104,424.28	242,320	10.19	17,187,474	722.80
	1902	21,778,196	913	810	103	814,728	37.41	517,549	23.76	1,269,331,001	58,284.49	169,554	7.79	8,561,205	393.11
Per cent of increase		9.2	17.2	13.6	45.6	88.4		103.8		95.6		42.9		100.8	
South Atlantic	1907	11,574,988	390	232	158	295,265	25.51	195,309	16.87	266,437,175	23,018.35	27,103	2.34	1,915,725	165.51
	1902	10,770,414	251	176	75	92,641	8.60	62,301	5.78	102,990,575	9,562.36	17,183	1.60	611,001	56.73
Per cent of increase		7.5	55.4	31.8	110.7	218.7		213.5		158.7		57.7		213.5	
North Central	1907	29,026,645	2,095	1,368	727	1,219,916	42.03	805,012	27.73	1,462,114,001	50,371.44	204,248	7.04	14,269,544	491.60
	1902	27,087,206	1,706	1,178	528	539,669	19.92	375,514	13.86	645,062,113	23,814.27	145,529	5.37	6,176,919	228.04
Per cent of increase		7.2	22.8	16.1	37.7	126.0		114.4		126.7		40.3		131.0	
South Central	1907	16,368,558	679	513	166	244,422	14.93	165,969	10.14	257,387,610	15,724.51	39,794	2.43	2,697,115	164.77
	1902	14,651,535	404	323	81	117,192	8.00	82,259	56.14	153,905,350	10,504.38	23,320	1.59	1,022,298	69.77
Per cent of increase		11.7	68.1	58.8	104.9	108.6		101.8		67.2		70.6		163.8	
Western	1907	4,783,557	480	429	51	803,999	168.08	488,407	102.10	1,393,231,724	291,254.34	42,248	8.83	5,376,139	1,123.88
	1902	4,289,085	346	318	28	280,818	65.47	174,612	40.71	335,762,076	78,282.91	30,112	7.02	1,822,621	424.94
Per cent of increase		11.5	38.7	34.9	82.1	186.3		179.7		315.0		40.3		195.0	

[1] Based upon Bureau of the Census estimates.
[2] Includes capacity of auxiliary engines, amounting to 65,823 horsepower in 1907 and 14,454 horsepower in 1902.
[3] In 1907, exclusive of 162,338 lamps of "Other varieties—Nernst, vacuum, vapor, etc."—the revenue for which is included with the income for lighting, and 275,079 lamps used by the central stations to light their own electric properties. These lamps were not reported separately in 1902.
[4] The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.

The comparison of the population of these geographic divisions with the several items of Table 7 representing the equipment and output of the stations may be roughly summarized as follows: The North Central, one-third of all items; the North Atlantic, one-fourth of the population and two-fifths of the other items; the South Atlantic and South Central combined, one-third of the population and one-eighth of the other items; and the Western, one-twentieth of the population and one-sixth of the other items. Comparing the proportion of population with that for the number of stations, the proportion of stations was larger than that for population for the North Central and Western divisions, and smaller for the North Atlantic, South Atlantic, and South Central divisions.

One of the most pronounced features of the central-station industry is the large per capita showing for the Western division, the output of stations and all the items of equipment, except arc lamps, being the largest of any group. The Western division, having, in 1907, less than 5,000,000 population, as compared with a population of upward of 11,000,000 and 16,000,000 for the South Atlantic and South Central divisions, respectively, reported a greater primary horsepower, a larger dynamo capacity, and more incandescent lamps wired for service than the two latter divisions combined. In per capita showing, the North Atlantic division was second in rank, the North Central third, the South Atlantic fourth, and the South Central fifth.

Mention has already been made of the fact that numerous tables in the report for 1902 contained statistics for the central stations, grouped according to the population of the places in which the stations were located. Such a presentation of the statistics is interesting, but the following points should be considered in connection with the results:

1. The reports for the central stations are assigned to the places in which the plants are located.

2. The development of the alternating current by means of the single-phase or polyphase dynamo, referred to in the report of 1902, has continued since that census, until at the census of 1907 the kilowatt capacity of this class of machines represented 82 per cent of the total dynamo capacity of all central stations. In many instances large plants are now located at places where water power is available for the generation of the current, but at great distances from the places where the current is used. It is evident that any attempt to arrive at the true per capita consumption of current, and other features based on population by localities, should include the statistics for these generating plants, but this is impossible, since they frequently furnish current to two or more widely separated cities, mills, or factories. The following are among the most notable examples of this phase of the development and use of electrical energy: In California two companies have plants located in several small places where water power is available for the generation of electricity, which is not only transmitted to the largest cities in the state but is used in numerous smaller places in the course of its transit. In New York the electrical energy generated at Niagara Falls is distributed to various cities and towns in the state. In South Carolina there is one large company with generating plants at places where there

Digitized by Google

is water power, from which places the electrical energy is transmitted to various sections of that state. If necessary, many other instances of this character of electric service might be given, but these are deemed sufficient for the purpose.

3. Some electric companies, though owning two or more central stations situated in widely separated places, made but one report covering all of their properties. As a rule, such reports are assigned to the place in which the principal plant is located. In some instances these plants are in two or more of the groups of cities for which separate statistics were shown in 1902, and the assignment of all of them to a certain city or group of cities would detract from the value of conclusions based upon population.

A majority of the central stations, however, are located in the cities to which they are assigned and where all of their output, or the major portion, is consumed. While, therefore, this grouping of the stations in 1902 by population may have been instructive to some extent, the defects are too great, so far as relates to the commercial stations, to warrant such an analysis at the census of 1907. Statistics are presented, however, for the following 34 selected cities, grouped in four classes according to size:

Thirty-four selected cities grouped in four classes according to their estimated population in 1902.

500,000 and over.	100,000 but under 500,000.	25,000 but under 100,000.	5,000 but under 25,000.
Chicago, Ill.	Cincinnati, Ohio.	Dayton, Ohio.	Anderson, Ind.
New York, N. Y.	Cleveland, Ohio.	Des Moines, Iowa.	Cumberland, Md.
Philadelphia, Pa.	Denver, Colo.	Duluth, Minn.	Flint, Mich.
St. Louis, Mo.	Indianapolis, Ind.	Erie, Pa.	Hannibal, Mo.
	Louisville, Ky.	Evansville, Ind.	Lewiston, Me.
	Minneapolis, Minn.	Holyoke, Mass.	Northampton, Mass.
	New Orleans, La.	Mobile, Ala.	Oklahoma City, Okla.
	St. Paul, Minn.	Reading, Pa.	Paducah, Ky.
	Washington, D. C.	San Antonio, Tex.	Richmond, Ind.
	Worcester, Mass.	Wilmington, Del.	Shreveport, La.

In the selection of these 34 cities, the rule followed was to limit them to those in which all the electrical energy used was practically generated within their respective limits and but little, if any, sold for outside consumption. Although the selection was to some extent an arbitrary one, the cities are fairly representative of the various sections of the country. These 34 cities contained 75 stations in 1907 and 70 stations in 1902, the character of ownership of which in 1907 was as follows: Corporate, 61; and municipal, 14. In 1902, 58 were corporate; 11, municipal; and 1, individual.

Digitized by Google

TABLE 8.—CENTRAL ELECTRIC STATIONS IN 34 SELECTED CITIES, BY GROUPS, ACCORDING TO POPULATION: 1907 AND 1902.

[The cities are grouped according to their estimated population in 1902, in order that the groups for the two census years may be identical.]

	THIRTY-FOUR CITIES.			FOUR CITIES, EACH HAVING A POPULATION OF 500,000 AND OVER.		
	1907	1902	Per cent of increase.	1907	1902	Per cent of increase.
Population [1]	12,088,994	10,546,858	14.6	8,461,375	7,381,580	14.6
Number of stations	75	70	7.1	24	22	9.1
Stock outstanding	$186,133,534	$136,115,950	36.7	$132,860,934	$105,086,650	26.4
Dividends	$7,017,001	$1,857,305	277.8	$5,232,927	$1,033,534	406.3
Bonds outstanding	$181,078,998	$108,571,302	66.8	$135,130,396	$93,030,502	45.3
Cost of construction and equipment	$338,870,083	$133,825,427	153.2	$240,009,024	$91,212,353	163.1
Gross income	$53,242,154	$25,126,735	111.9	$38,868,287	$18,087,346	114.9
Electric service	$52,039,498	$24,968,991	108.4	$37,922,680	$18,073,643	109.8
Lighting	$39,583,359	$20,833,882	90.0	$28,409,863	$15,051,352	88.8
Stationary motors	$9,397,205	$3,919,455	139.8	$6,894,775	$2,958,604	133.0
All other	$3,058,934	$215,654	1,318.4	$2,618,042	$63,687	4,010.8
All other sources	$1,202,656	$157,744	662.4	$945,607	$13,703	6,800.7
Total expenses	$29,753,204	$15,282,933	94.7	$20,485,942	$10,755,734	90.5
Cost of supplies and materials	$3,784,641	$2,952,346	28.2	$2,337,290	$2,181,129	7.2
Cost of fuel	$5,527,510	$2,493,049	121.7	$3,647,844	$1,656,792	120.2
Power purchased	$1,121,079	$213,929	424.0	$668,281	$15,700	4,156.6
Miscellaneous expenses	$10,130,039	$4,184,971	142.1	$7,246,844	$2,916,276	148.5
Salaries and wages	$9,189,935	$5,438,638	69.0	$6,585,683	$3,935,837	65.2
Salaried officials, clerks, etc.:						
Number	2,568	1,219	110.7	1,895	849	123.2
Salaries	$2,851,745	$1,291,172	120.9	$2,104,888	$924,128	127.8
Wage-earners:						
Average number	9,000	5,727	57.2	6,092	4,071	49.6
Wages	$6,338,190	$4,147,466	52.8	$4,480,795	$3,061,709	46.3
Primary power: [2]						
Number of machines	585	485	20.6	276	234	17.9
Horsepower capacity	908,776	338,461	168.5	578,120	212,990	171.4
Generating equipment:						
Number of dynamos	979	1,584	[2]38.2	460	925	[2]50.3
Kilowatt capacity	639,195	218,688	192.3	415,979	133,247	212.2
Output of stations, kilowatt hours	1,337,608,288	479,132,378	179.2	989,516,589	303,435,153	226.1
Lamps wired for service: [4]						
Arc	183,731	111,437	64.9	120,169	70,376	70.8
Incandescent [5]	11,522,603	5,484,938	110.1	7,833,661	4,069,473	92.5
Other varieties—Nernst, vacuum, vapor, etc	56,391	([6])	.....	40,779	([6])	.....

	TEN CITIES, EACH HAVING A POPULATION OF 100,000 BUT UNDER 500,000.			TEN CITIES, EACH HAVING A POPULATION OF 25,000 BUT UNDER 100,000.			TEN CITIES, EACH HAVING A POPULATION OF 5,000 BUT UNDER 25,000.		
	1907	1902	Per cent of increase.	1907	1902	Per cent of increase.	1907	1902	Per cent of increase.
Population [1]	2,693,310	2,354,704	14.4	719,613	632,582	13.8	214,696	177,992	20.6
Number of stations	23	24	[2]4.2	15	12	25.0	13	12	8.3
Stock outstanding	$37,739,390	$26,490,600	42.5	$13,105,760	$3,855,000	240.0	$2,427,400	$683,700	255.0
Dividends	$1,471,099	$709,775	107.3	$253,200	$106,300	138.2	$59,775	$7,096	676.7
Bonds outstanding	$27,490,900	$12,058,500	128.0	$15,208,712	$2,884,000	427.3	$3,249,000	$598,500	442.9
Cost of construction and equipment	$69,756,748	$34,512,803	102.1	$24,296,933	$7,007,488	246.7	$4,807,378	$1,092,783	339.9
Gross income	$10,676,631	$5,236,059	103.9	$2,739,816	$1,436,751	90.7	$957,420	$366,579	161.2
Electric service	$10,520,506	$5,155,661	104.1	$2,678,781	$1,376,328	94.6	$917,531	$363,359	152.5
Lighting	$8,360,722	$4,236,520	97.3	$2,078,740	$1,214,683	71.1	$734,034	$331,327	121.5
Stationary motors	$1,964,718	$783,567	150.7	$417,766	$151,013	176.6	$119,946	$26,271	356.6
All other	$195,066	$135,574	43.9	$182,275	$10,632	1,614.4	$63,551	$5,761	1,000.3
All other sources	$156,125	$80,398	94.2	$61,035	$60,423	1.0	$39,889	$3,220	1,138.8
Total expenses	$6,836,562	$3,355,435	103.7	$1,820,351	$935,969	94.5	$610,349	$235,795	158.8
Cost of supplies and materials	$1,101,472	$554,705	98.6	$284,886	$180,875	57.5	$60,993	$35,637	71.2
Cost of fuel	$1,237,747	$627,804	97.2	$447,154	$141,820	215.3	$194,765	$66,633	192.3
Power purchased	$229,526	$106,990	114.5	$219,525	$91,239	140.6	$3,747	.....	.....
Miscellaneous expenses	$2,346,609	$995,084	135.8	$378,083	$235,083	60.8	$158,503	$38,528	311.4
Salaries and wages	$1,921,208	$1,070,852	79.4	$490,703	$286,952	71.0	$192,341	$94,997	102.5
Salaried officials, clerks, etc.:									
Number	433	255	69.8	171	76	125.0	69	39	76.9
Salaries	$523,893	$252,702	107.3	$160,116	$84,407	89.7	$62,848	$29,935	109.9
Wage-earners:									
Average number	2,163	1,255	72.4	544	292	86.3	201	109	84.4
Wages	$1,397,315	$818,150	70.8	$330,587	$202,545	63.2	$129,493	$65,062	99.0
Primary power: [3]									
Number of machines	174	153	13.7	94	62	51.6	41	36	13.9
Horsepower capacity	218,178	91,916	126.5	93,982	24,650	281.3	18,496	8,905	107.7
Generating equipment:									
Number of dynamos	292	432	[2]32.4	160	150	6.7	67	77	[2]12.0
Kilowatt capacity	147,439	64,147	129.8	62,603	16,210	286.2	13,174	5,064	159.1
Output of stations, kilowatt hours	249,286,502	119,533,836	108.5	73,547,640	35,156,654	109.2	25,257,557	21,006,735	20.2
Lamps wired for service: [4]									
Arc	47,308	30,792	53.6	11,958	7,431	60.9	4,296	2,838	51.4
Incandescent [5]	2,769,920	1,112,946	148.9	703,211	231,114	204.3	215,811	71,405	202.2
Other varieties—Nernst, vacuum, vapor, etc	5,083	([6])	.....	10,211	([6])	.....	318	([6])	.....

[1] Based upon Bureau of the Census estimates.
[2] Decrease.
[3] Exclusive of auxiliary engines with a total capacity of 10,659 horsepower in 1907 and 3,562 horsepower in 1902.
[4] Exclusive of 52,020 lamps used by the central stations to light their own electric properties in 1907. These lamps were not reported separately in 1902.
[5] The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.
[6] Not reported separately.

Digitized by Google

While the principal income of central stations is derived from lighting and stationary-motor service, electricity is being used for a constantly increasing variety of purposes. The income as reported from these miscellaneous uses is shown in Table 8 as "All other" under "Electric service." The several items composing this total are shown in Table 9.

TABLE 9.—*Central electric stations in 34 selected cities—Income from "All other electric service:" 1907 and 1902.*

	1907	1902	Per cent of increase.
Total	$3,058,934	$215,654	1,318.4
Electric-railway service	1,960,551	138,275	1,317.9
Sales to other electric companies	779,728		
Heating, cooking, welding, etc	117,560	23,451	401.3
Charging automobiles	135,121	24,775	445.4
Miscellaneous electric service	65,974	29,153	126.3

More than nine-tenths of the gain in "Other electric service" was from the sale of current to electric-railway companies and to other companies engaged in the sale and distribution of current. The percentages of increase for the remaining items are large, but the actual amounts of income involved are comparatively small. The greater part of the income from "Miscellaneous electric service" was derived from the use of current to operate electric fans.

Although not shown in Table 8, certain facts connected with the generating plants in the 34 cities are briefly summarized, as follows: In 1907 nearly one-fourth of the primary power for the 4,714 central stations in the United States was connected with the 75 stations in these selected cities. The proportion of steam power in the total primary power in these cities was 92.5 per cent in 1907 and 98.7 per cent in 1902, as compared with 65.2 per cent and 75.4 per cent, respectively, for the United States. As illustrative of the extensive use of the steam turbine in the more thickly settled communities, 55.6 per cent of the total horsepower reported for steam turbines in the central stations in the United States was reported by the stations in these 34 selected cities. Chicago claims the distinction of having the largest prime mover in the world, a steam turbine of 22,000 horsepower, several more of which are about to be installed in the same station. The gas engine was very little used in these cities, only 4 engines with a total of 60 horsepower being reported in 1907, all in the group of cities of over 500,000 population. In 1902 the group of cities "5,000 but under 25,000" was the only one not reporting gas engines, although but 300 horsepower of this character was reported for the 34 cities, which formed only one-tenth of 1 per cent of the total for all kinds of primary power. A considerable increase in water power is shown, from 1.2 per cent in 1902 to 7.6 per cent in 1907. No water power was reported in the 4 cities of over 500,000 population, but it is shown for each of the remaining groups. The increase in water power was not due to the general adoption of this form of primary power, as nearly nine-tenths of the total increase was confined to two companies, one in the group of cities of 100,000 but under 500,000 population, where the water power increased from 2,400 horsepower in 1902 to 19,600 horsepower in 1907, and the other in the group of cities of 25,000 but under 100,000 population, in which there has been installed since 1902 a plant reporting water wheels of 39,700 horsepower. Although this latter plant was reported in 1907, it had been in operation but a few months and at only a fraction of the capacity reported.

Exclusive of the horsepower of the gas engines, which was comparatively insignificant, the horsepower capacity reported by all central stations in the United States in 1907 was about two-thirds steam and one-third water. In 1902 the proportions were about three-fourths steam and one-fourth water. For the 34 cities in 1907 more than nine-tenths was steam and less than one-tenth water, while in 1902 practically all the primary power was steam.

The generating equipment for the 34 selected cities, which is reported in bulk in Table 8, is shown in detail in Table 10.

TABLE 10.—*Central electric stations in 34 selected cities—Generating equipment: 1907 and 1902.*

KIND OF DYNAMO.	Census.	Thirty-four cities.	Four cities, each having a population of 500,000 and over.	Ten cities, each having a population of 100,000 but under 500,000.	Ten cities, each having a population of 25,000 but under 100,000.	Ten cities, each having a population of 5,000 but under 25,000.
Number of stations	1907	75	24	23	15	13
	1902	70	22	24	12	12
Dynamos:						
Number	1907	979	460	292	160	67
	1902	1,584	925	432	150	77
Kilowatt capacity	1907	639,195	415,979	147,439	62,603	13,174
	1902	218,688	133,247	64,147	16,210	5,084
Direct-current, constant-voltage:						
Number	1907	312	125	96	70	21
	1902	432	192	150	64	26
Kilowatt capacity	1907	95,956	38,984	40,275	13,798	2,899
	1902	94,552	50,927	34,943	7,207	1,475
Direct-current, constant-amperage:						
Number	1907	385	218	109	41	17
	1902	702	401	210	60	31
Kilowatt capacity	1907	23,748	15,505	5,579	2,069	595
	1902	37,222	22,287	11,214	2,703	1,018
Alternating single-phase and polyphase current:						
Number	1907	282	117	87	49	29
	1902	450	332	72	26	20
Kilowatt capacity	1907	519,491	361,490	101,585	46,736	9,680
	1902	86,914	60,033	17,990	6,300	2,591

The kilowatt capacity of the dynamos in the 34 selected cities formed about the same proportion of the total for the United States, slightly less than one-fourth, as did the primary power. The percentage of increase, however, was considerably larger for the 34 cities than for the United States. The kilowatt

Digitized by Google

capacity of the direct-current, constant-voltage dynamos, which increased 23.1 per cent in the United States, practically remained stationary in the total for the 34 cities, the increase being less than 2 per cent. An actual loss is shown for the 4 cities of largest population, which, however, is slightly overcome by gains in each of the other three groups. The capacity of the direct-current, constant-amperage dynamo decreased in each of the several groups of cities, in harmony with the decrease shown for this class of dynamo in the total for the United States. The capacity of the alternating single-phase and polyphase current dynamo increased in each group, and the percentage of gain for the 34 cities together was much greater than that for the country as a whole.

Notwithstanding the gain in kilowatt capacity of the dynamos there was a general decrease in their number, which fact harmonizes with the conclusions in the chapter treating of the generating equipment of all central stations, where the average capacity of the dynamos in 1907 is shown to be much larger than was reported in 1902.

Large and small stations.—As previously explained, the classification of "central station" is based on the character of the service and not on the size of the plant. No limit was placed on the size of the plants to be enumerated, and although there are some very large stations, the vast majority are comparatively small. The commercial stations range from the one located at Stanton, Iowa, with gas as the primary power and a dynamo of 3-kilowatt capacity, to one in New York City having steam as the primary power and a total dynamo capacity of 149,300 kilowatts. The municipal stations range from the one located at Bath, Ill., also with gas as the primary power and a dynamo capacity of 6 kilowatts, to that located at Chicago, with steam as the primary power and a total dynamo capacity of 5,473 kilowatts. Table 11 classifies the stations according to dynamo capacity.

TABLE 11.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER, BY DYNAMO CAPACITY OF STATIONS: 1907 AND 1902.

DYNAMO CAPACITY OF STATION.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT DISTRIBUTION.					
							Total.		Commercial.		Municipal.	
	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902
Total	4,714	3,620	3,462	2,805	1,252	815	100.0	100.0	100.0	100.0	100.0	100.0
Under 200 kilowatts	3,038	2,587	2,116	1,890	922	697	64.4	71.5	61.1	67.4	73.6	85.5
200 but under 500 kilowatts	821	586	584	497	237	89	17.4	16.2	16.9	17.7	18.9	10.9
500 but under 1,000 kilowatts	269	172	225	160	44	12	5.7	4.8	6.5	5.7	3.5	1.5
1,000 but under 2,000 kilowatts	169	98	159	92	10	6	3.6	2.7	4.6	3.3	0.8	0.7
2,000 but under 5,000 kilowatts	115	66	111	64	4	2	2.4	1.8	3.2	2.3	0.3	0.2
5,000 kilowatts and over	75	33	74	32	1	1	1.6	0.9	2.1	1.1	0.1	0.1
Stations having no generating equipment	227	78	193	70	34	8	4.8	2.2	5.6	2.5	2.7	1.0

The extent of the predominance of the small station is evident from the fact that 81.8 per cent of all stations in 1907 and 87.7 per cent in 1902 were under 500-kilowatt capacity, while considerably more than one-half of all, 64.4 per cent in 1907 and 71.5 per cent in 1902, were under 200-kilowatt capacity. As would be expected, the number of stations in the various classes grows proportionately less as the classes increase in dynamo capacity.

Of the commercial stations, 16.4 per cent in 1907 and 12.4 per cent in 1902 were embraced in the classes which had a kilowatt capacity of 500 horsepower or over, while of the municipal stations, only 4.7 per cent in 1907 and 2.5 per cent in 1902 reported this capacity. Although the percentages of increase are almost uniformly larger for the municipal stations, in but one class, that of "200 but under 500 kilowatts," was the actual increase the greater. The commercial stations made the only increase in the class of largest dynamo capacity, there being but one municipal station of this class both in 1907 and 1902, which was located in Chicago. Except for a small amount of current sold to other electric companies, this plant was engaged exclusively in arc lighting.

The distribution, by dynamo capacity, of the purely electric and of the composite stations is shown in Table 12.

For all the stations supplied with dynamos the percentages of increase were uniformly greater for the composite stations. In this group the proportion of small stations, or those under 500-kilowatt capacity, was 83.8 per cent in 1907 and 89.8 per cent in 1902 as compared with 80.4 and 86.2 per cent, respectively, for the purely electric. Among the purely electric stations the larger plants are a little more numerous, relatively, than among the composite stations. It appears, however, that the manufacture of electric current on a large scale is combined with other lines of work almost as much as the manufacture of current on a small scale.

Digitized by Google

TABLE 12.—PURELY ELECTRIC AND COMPOSITE CENTRAL ELECTRIC STATIONS—NUMBER, BY DYNAMO CAPACITY OF STATIONS: 1907 AND 1902.

DYNAMO CAPACITY OF STATION.	TOTAL.		PURELY ELECTRIC.		COMPOSITE.		PER CENT DISTRIBUTION.					
							Total.		Purely electric.		Composite.	
	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902
Total	4,714	3,620	2,648	2,139	2,066	1,481	100.0	100.0	100.0	100.0	100.0	100.0
Under 200 kilowatts	3,038	2,587	1,692	1,477	1,346	1,110	64.4	71.5	63.9	69.1	65.2	74.9
200 but under 500 kilowatts	821	586	436	366	385	220	17.4	16.2	16.5	17.1	18.6	14.9
500 but under 1,000 kilowatts	269	172	140	96	129	76	5.7	4.8	5.3	4.5	6.2	5.1
1,000 but under 2,000 kilowatts	169	98	80	69	89	29	3.6	2.7	3.0	3.2	4.3	2.0
2,000 but under 5,000 kilowatts	115	66	70	48	45	18	2.4	1.8	2.6	2.2	2.2	1.2
5,000 kilowatts and over	75	33	48	23	27	10	1.6	0.9	1.8	1.1	1.3	0.7
Stations having no generating equipment	227	78	182	60	45	18	4.8	2.2	6.9	2.8	2.2	1.2

The distribution of the stations by dynamo capacity is shown by geographic divisions in Table 13.

The Western division, although having in 1907 less than one-half the population of any of the other divisions, had more stations of 1,000-kilowatt capacity and over than either the South Atlantic or the South Central divisions, and in the largest class of 5,000 and over, nearly double the number for these two divisions combined. Another noticeable feature connected with the Western division is the relatively large number of stations not equipped with dynamos, being exceeded in this respect only by the North Atlantic division. In 1907, although not shown in Table 13, there were 4 states each of which had more than ten stations not possessing electric generators, as follows: California, 40; New York, 30; Pennsylvania, 30; and Massachusetts, 18. In 1902 such stations were reported by these states as follows: California, 25; New York, 4; Pennsylvania, 11; and Massachusetts, 5. These figures show that California had considerably the largest number of stations dependent upon other plants for their electrical energy, and this showing may be explained by the fact that in this state exceptionally long transmission lines are used, the electricity in one instance being generated upward of 200 miles from the places where it is chiefly used.

TABLE 13.—CENTRAL ELECTRIC STATIONS—NUMBER, BY DYNAMO CAPACITY AND BY GEOGRAPHIC DIVISIONS: 1907 AND 1902.

DIVISION.	TOTAL.		UNDER 200 KILOWATTS.		200 BUT UNDER 500 KILOWATTS.		500 BUT UNDER 1,000 KILOWATTS.		1,000 BUT UNDER 2,000 KILOWATTS.		2,000 BUT UNDER 5,000 KILOWATTS.		5,000 KILOWATTS. AND OVER.		STATIONS HAVING NO GENERATING EQUIPMENT.	
	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902
Total	4,714	3,620	3,038	2,587	821	586	269	172	169	98	115	66	75	33	227	78
North Atlantic	1,070	913	481	499	224	216	113	86	76	42	50	26	27	15	99	29
South Atlantic	390	251	250	201	90	35	11	4	10	2	8	6	7	1	14	2
North Central	2,095	1,706	1,527	1,347	346	241	95	60	47	25	27	19	20	6	33	8
South Central	679	404	530	328	98	48	20	11	11	10	12	4	3	1	5	2
Western	480	346	250	212	63	46	30	11	25	19	18	11	18	10	76	37

Consolidation of electric stations with other enterprises.—In 1907 an effort was made to ascertain the extent of the association of other industries with central electric stations, and the results are presented in the following statement:

Commercial and municipal central electric stations—Number and kind of associated enterprises: 1907.

	Total.	Commercial.	Municipal.
United States	4,714	3,462	1,252
Purely electric	2,648	2,127	521
Composite	2,066	1,335	731
Total associated enterprises	2,306	1,568	738
Waterworks	1,036	320	716
Gas plants[1]	329	317	12
Lumber and grist mills	310	307	3
Ice manufacture	212	212	.....
Steam heating	118	114	4
Cotton gins	35	35	.....
Electric railways	32	32	.....
Miscellaneous	234	231	3

[1] Manufactured gas.

Of the 4,714 central electric stations, the composite central stations, or those which were operated in connection with other industries, numbered 2,066. These stations were associated with 2,306 industries of various kinds, the excess of industries being due to the fact that a single central station may be associated with several other industries. The association of central stations with waterworks and gas plants is the most common, and for the municipal plants there was practically no other. For the commercial stations there were 995 operated in connection with such public service as waterworks, gas works, street railways, steam heating, and the manufacture of ice, and 573 stations operated in connection with some other business. The central stations associated with such industries as sawmills, gristmills, manufactured ice, and cotton gins, are likely to be of secondary importance, and owe their existence to the facility with which surplus primary power, by use of the

Digitized by Google

dynamo, may be converted into electrical energy and transmitted for service as light or power to near-by or remote points.

Of the various industries mentioned, the manufacture of illuminating gas comes into the most direct competition with the generation of electrical energy, and a comparative summary of the two industries is shown in Table 14.

TABLE 14.—COMPARATIVE SUMMARY—CENTRAL ELECTRIC STATIONS AND GAS PLANTS.

	CENTRAL ELECTRIC STATIONS.		GAS PLANTS.		PER CENT OF INCREASE.	
	1907	1902	1905	1900	Central electric stations.	Gas plants.
Number of establishments	4,714	3,620	1,019	877	30.2	16.2
Cost of construction and equipment	$1,096,913,622	$504,740,352	[1]$725,035,204	[1]$567,000,506	117.3	27.9
Gross income	$175,642,338	$85,700,605	$125,144,945	$75,716,693	104.9	65.3
From sale of electric current or gas	$169,614,691	$84,186,605	$112,662,568	$69,432,582	101.5	62.3
From all other sources	$6,027,647	$1,514,000	$12,482,377	$6,284,111	298.1	98.6
Cost of supplies, materials, power purchased, and fuel	$44,458,568	$22,915,932	$37,180,066	$20,605,356	94.0	80.4
Salaried officials, etc.:						
Number	12,990	6,996	9,406	5,904	85.7	59.3
Salaries	$11,733,787	$5,663,580	$8,463,699	$5,273,500	107.2	60.5
Wage-earners:						
Average number	34,642	23,330	30,566	22,459	48.5	36.1
Wages	$23,686,537	$14,983,112	$17,057,917	$12,436,296	58.1	37.2

[1] Capital invested—owned and borrowed.

Although the statistics for the two industries in Table 14 do not cover the same years, they represent the results of two censuses taken at five-year intervals, the respective census years being sufficiently near together for purposes of general comparison. The respective costs of construction for the two industries are based upon too widely different constituents to warrant their use except as they show the comparative growth of each industry. This item for electric stations represents the total cost of plants and equipment, and that for the gas plants embraces the capital invested—owned and borrowed. The percentages of increase for the central stations are uniformly greater than for the gas plants, although those for the latter industry are surprisingly large considering the competition of the newer industry.

The item most comparable is that which represents the income from the sale of electrical energy in one industry and from the sale of gas in the other. The income represented by this item not only constitutes in each industry more than 90 per cent of the total from all sources, but the chief uses of the electricity and manufactured gas are for identical purposes. A comparison of this source of income shows an increase of 101.5 per cent for the central stations and 62.3 per cent for the gas plants. It is to be remembered that the census figures for central stations in Table 14 do not embrace all that properly belongs to the central-station industry, since electric-railway companies sell electric current, amounting in 1907 to upward of $20,000,000 worth, and thousands of isolated private stations exist which were not included in the census. There are likewise many isolated private gas plants, but the number is believed to be insignificant compared with the isolated electric plants.

In 1907, 329 stations reported that they also operated gas plants, but this by no means represents the extent to which the consolidation of the interests of the two industries has been carried, since it does not cover instances wherein the whole, or a controlling portion, of the stock of one industry has been acquired by the other, and the companies are operated under separate management regardless of stock ownership. There is a growing tendency to merge the two industries partly to avoid the sharp competition whenever they are common bidders for the same class of business.

MUNICIPAL PLANTS.

A comparison of the number of reports received from municipal stations in 1907 with the number received in 1902 shows an increase of 53.6 per cent as compared with 23.4 per cent for the commercial companies. The municipal stations are practically exempt from the consolidations that so frequently occur among commercial companies, and this fact no doubt accounts in large part for the proportionately greater increase in the former class of stations. Not only was there a large increase in the number of municipal stations, but an analysis of the reports shows that although 33 municipal stations which reported in 1902 had become commercial stations in 1907, 113 stations which were reported as commercial in 1902 had become municipal in 1907. The claim has been made, and sustained by what appears to be reasonable argument, that the drift of these public utilities is from municipal to commercial, but the results of the census do not furnish corroborative evidence of this. On the contrary there appears to be a distinct field for municipal electric stations, not only because of a feeling which may exist in many localities that these public utilities should be owned by the cities, but because many of the places in which municipal plants are located do not present sufficient inducement for the investment of commercial capital.

Digitized by Google

TABLE 15.—*Municipal central electric stations—Number, with additions since 1902, by geographic divisions: 1907.*

DIVISION.	Total reported in 1907.	Reported in 1902 and 1907.	Constructed since 1902.	Commercial in 1902 and municipal in 1907.	In operation in 1902 but not reported at that census.
Total	1,252	774	348	113	17
North Atlantic	150	100	39	9	2
South Atlantic	158	72	66	17	3
North Central	727	502	160	57	8
South Central	166	77	63	24	2
Western	51	23	20	6	2

The stability of these plants is exemplified by the fact that 774 of the 815 municipal plants reported in 1902 also reported in 1907. Of the 41 which failed to report in 1907, 33 had become commercial stations, as previously noted; 4 had discontinued operations or were idle; 2 were connected with public institutions, the plants of which were excluded from the census of 1907; 1 was merged with another municipal plant because of the consolidation of two cities since 1902; and 1 was destroyed by fire and had not been rebuilt at the time of taking the census of 1907.

Reasons have already been given for the omission of the statistics of central stations, classified by the population of the places in which the plants were located. The objections, which are pronounced for the commercial stations, are not, however, deemed sufficient to warrant the omission of general statistics for the municipal stations showing distribution by population grouping. The number of these stations in each geographic division by population groupings is presented in Table 16.

TABLE 16.—*Municipal central electric stations—Number, by population of cities in which located and by geographic divisions: 1907 and 1902.*

[The cities have been grouped according to their population in 1900.]

DIVISION.	Census.	Total.	NUMBER OF STATIONS IN CITIES HAVING A POPULATION OF—				
			Under 5,000.	5,000 but under 25,000.	25,000 but under 100,000.	100,000 but under 500,000.	500,000 and over.
Total	1907	1,252	1,081	142	17	6	6
	1902	815	671	121	13	6	4
North Atlantic	1907	150	107	38	3	1	1
	1902	103	68	31	2	2	.....
South Atlantic	1907	158	142	13	2	.....	1
	1902	75	62	11	2	.....	.....
North Central	1907	727	636	76	6	5	4
	1902	528	449	67	4	4	4
South Central	1907	166	152	10	4	.....	.....
	1902	81	68	9	4	.....	.....
Western	1907	51	44	5	2	.....	.....
	1902	28	24	3	1	.....	.....

Table 16 shows that most of the municipal stations are in places of small population, nearly seven-eighths of the total number being located in places of less than 5,000 population and less than 3 per cent in places having a population of 25,000 and over. In the 3 divisions—the South Atlantic, the South Central, and the Western—together, only 1 station was reported in 1907 for cities of over 100,000 population, but it is to be remembered that in these 3 divisions together there were only 8 cities of this class according to the census of 1900. In the North Atlantic division there were 16 cities of this class, with only 2 municipal plants in 1907; and in the North Central, 14 cities, with 9 municipal plants. The 1 station reported for the South Atlantic division was in Baltimore, while the 4 stations in the "500,000 and over" class in 1907 and 1902 in the North Central division were all located in Chicago.

Table 17 gives detailed statistics of municipal stations, classified according to population of places in which located.

Although, as already noticed, the group of smallest population embraced seven-eighths of the total number of municipal stations, their proportion of other leading items in the table was smaller, varying from about one-half to two-thirds, except for the number of arc lamps, for which the proportion was only about three-eighths. Nearly one-eighth of the total number of stations were found in the next higher group, "5,000 but under 25,000," and these stations reported about one-fourth of the totals for the several chief items. For the remaining three groups, the various items of finance, equipment, and output were naturally much out of proportion to the number of stations. For the group "25,000 but under 100,000," the leading items averaged roughly 9 per cent of their several totals, and for each of the two groups embracing the cities of largest population, 5 or 6 per cent. In the stations of the cities of largest population the high proportion of arc lamps as compared with incandescent lamps is noteworthy, and clearly indicates the character of the service of the few stations in the large cities.

The North Central division reported considerably more than one-half of the total number of municipal stations and the same proportion of all the other chief items in Table 17. The North Atlantic division stood second. The figures for the stations in the South Central and South Atlantic divisions are about equal as a whole, and those for the Western division the smallest in every respect, except for incandescent and for "Other varieties" of lamps.

Digitized by Google

TABLE 17.—MUNICIPAL CENTRAL ELECTRIC STATIONS, BY POPULATION OF CITIES

[The cities have been grouped

	DIVISION AND POPULATION GROUP.	Census.	Number of stations.	Cost of construction and equipment.	INCOME.		
					Total.	Electric service.	All other sources.
1	Total	1907	1,252	$42,879,447	$14,011,999	$13,614,434	$397,565
2		1902	815	22,020,473	6,965,105	6,836,856	128,249
3	Under 5,000	1907	1,081	21,476,667	7,631,842	7,337,260	294,582
4		1902	671	11,074,008	3,621,023	3,538,468	82,555
5	5,000 but under 25,000	1907	142	9,726,310	3,466,142	3,389,192	76,950
6		1902	121	5,605,178	1,765,000	1,732,897	32,103
7	25,000 but under 100,000	1907	17	4,823,033	1,414,810	1,408,521	6,289
8		1902	13	1,553,931	455,204	455,149	55
9	100,000 but under 500,000	1907	6	2,760,732	736,276	716,532	19,744
10		1902	6	1,607,803	441,235	427,699	13,536
11	500,000 and over	1907	6	4,092,705	762,929	762,929	.....
12		1902	4	2,179,553	682,643	682,643	.....
13	North Atlantic	1907	150	7,838,995	2,308,082	2,266,506	41,576
14		1902	103	3,942,139	1,089,531	1,075,283	14,248
15	Under 5,000	1907	107	3,088,388	872,150	845,774	26,376
16		1902	68	1,697,447	392,586	384,109	8,477
17	5,000 but under 25,000	1907	38	3,025,195	897,546	882,346	15,200
18		1902	31	1,510,923	424,886	419,115	5,771
19	25,000 but under 100,000 [2]	1907	5	1,725,412	538,386	538,386	.....
20		1902	4	733,769	272,059	272,059	.....
21	South Atlantic	1907	158	4,076,042	1,621,309	1,574,043	47,266
22		1902	75	1,561,938	583,162	577,479	5,683
23	Under 5,000	1907	142	2,973,002	1,072,023	1,027,220	44,803
24		1902	62	920,726	333,335	328,776	4,559
25	5,000 but under 25,000 [2]	1907	13	476,510	230,343	227,880	2,463
26		1902	13	641,212	249,827	248,703	1,124
27	25,000 but under 100,000 [4]	1907	3	626,530	318,943	318,943	.....
28	North Central	1907	727	22,955,162	7,403,015	7,142,752	260,263
29		1902	528	13,872,245	4,397,509	4,308,879	88,630
30	Under 5,000	1907	636	11,306,559	4,178,706	3,992,505	186,201
31		1902	449	7,151,667	2,396,828	2,338,038	58,790
32	5,000 but under 25,000	1907	76	4,828,705	1,829,198	1,775,195	54,003
33		1902	67	3,145,901	1,009,166	992,917	16,249
34	25,000 but under 100,000	1907	6	665,888	200,438	200,123	315
35		1902	4	302,811	87,817	87,762	55
36	100,000 but under 500,000	1907	5	2,177,490	472,801	453,057	19,744
37		1902	4	1,092,313	221,055	207,519	13,536
38	500,000 and over	1907	4	3,976,520	721,872	721,872	.....
39		1902	4	2,179,553	682,643	682,643	.....
40	South Central	1907	166	4,259,121	1,640,608	1,609,032	31,576
41		1902	81	1,582,386	566,146	554,208	11,938
42	Under 5,000	1907	152	3,046,244	1,133,925	1,104,549	29,376
43		1902	68	929,481	364,251	354,350	9,901
44	5,000 but under 25,000	1907	10	705,552	321,549	319,349	2,200
45		1902	9	364,730	142,742	140,705	2,037
46	25,000 but under 100,000	1907	4	507,325	185,134	185,134	.....
47		1902	4	288,175	59,153	59,153	.....
48	Western	1907	51	3,750,127	1,038,985	1,022,101	16,884
49		1902	28	1,061,765	328,757	321,007	7,750
50	Under 5,000	1907	44	1,062,474	375,038	367,212	7,826
51		1902	24	374,687	134,023	133,195	828
52	5,000 but under 25,000 [5]	1907	7	2,687,653	663,947	654,889	9,058
53		1902	4	687,078	194,734	187,812	6,922

[1] Not reported separately in 1902.
[2] Includes 1 station of the "100,000 but under 500,000" group and 1 station of the "500,000 and over" group in 1907, and 2 stations of the former group in 1902, in order that the operations of individual stations may not be disclosed.

Digitized by Google

IN WHICH LOCATED AND BY GEOGRAPHIC DIVISIONS: 1907 AND 1902.

according to their population in 1900.]

Total expenses.	Primary-power plant, total horsepower.	KILOWATT CAPACITY OF DYNAMOS.				Output of stations, kilowatt hours.	LAMPS WIRED FOR SERVICE.			
		Total.	Direct current.		Alternating single-phase and polyphase current.		Arc.	Incandescent.	Other varieties—Nernst, vacuum, vapor, etc.[1]	
			Constant voltage.	Constant amperage.						
$9,167,188	321,351	209,016	26,754	19,239	163,023	289,462,788	82,940	4,052,448	8,870	1
4,741,182	160,028	113,380	17,556	28,171	67,653	195,904,439	50,795	1,577,451	.....	2
5,298,119	194,172	130,174	22,179	5,176	102,819	146,906,359	30,888	2,719,249	3,270	3
2,620,167	96,282	64,650	13,450	7,229	43,971	105,518,293	19,611	1,094,946	.....	4
2,128,859	75,975	48,107	2,813	4,895	40,399	78,788,119	23,033	952,967	1,565	5
1,212,636	40,123	28,966	2,867	7,625	18,474	56,286,059	15,701	391,645	.....	6
778,358	25,763	14,812	942	2,465	11,405	29,815,562	9,549	325,548	3,738	7
315,139	7,713	5,394	927	1,892	2,575	8,929,900	4,800	66,840	.....	8
373,750	12,616	8,250	350	1,890	6,010	17,819,478	8,393	42,754	282	9
255,606	6,085	4,263	107	2,762	1,394	9,543,807	4,544	21,620	.....	10
588,102	12,825	7,673	470	4,813	2,390	16,133,270	11,077	11,930	15	11
337,634	9,825	10,107	205	8,663	1,239	15,626,380	6,139	2,400	.....	12
1,406,815	53,580	35,325	2,133	3,370	29,822	48,861,638	12,320	703,634	1,149	13
708,353	26,657	17,885	1,334	4,225	12,326	28,469,646	7,846	272,212	.....	14
567,090	24,240	16,103	771	905	14,427	17,742,732	3,546	397,819	446	15
294,739	13,967	8,528	660	954	6,914	12,624,636	2,387	151,985	.....	16
571,386	21,049	12,892	950	1,247	10,695	19,182,675	5,345	254,749	590	17
318,092	9,615	6,917	551	1,566	4,800	10,983,988	3,464	104,902	.....	18
268,339	11,291	6,330	412	1,218	4,700	11,936,231	3,429	51,066	113	19
154,922	3,075	2,440	123	1,705	612	4,861,022	1,995	15,325	.....	20
1,051,602	36,542	22,759	2,138	1,482	19,139	30,300,397	7,529	402,953	63	21
385,412	12,410	8,469	1,171	1,672	5,626	17,072,971	4,230	107,764	.....	22
720,425	25,119	17,349	1,543	232	15,574	18,283,131	4,650	294,643	40	23
240,438	8,070	5,215	798	574	3,843	10,349,782	2,010	68,843	.....	24
137,415	4,950	3,183	.....	568	2,615	4,563,870	1,715	43,880	23	25
144,974	4,340	3,254	373	1,098	1,783	6,723,189	2,220	38,921	.....	26
187,762	6,473	2,227	595	682	950	7,453,396	1,164	64,430	.....	27
5,072,384	176,221	115,990	19,240	13,477	83,273	159,005,189	52,327	2,204,135	3,609	28
2,938,805	102,895	73,169	12,578	20,704	39,887	127,865,521	33,595	1,014,120	.....	29
2,999,451	110,320	73,973	16,885	3,979	53,109	81,2[illegible]2,275	18,351	1,625,908	2,360	30
1,735,342	62,994	42,472	9,740	5,294	27,438	68,683,634	13,314	770,658	.....	31
1,127,782	40,166	26,042	1,705	2,678	21,659	43,628,086	13,544	521,401	945	32
658,289	24,123	16,843	2,005	4,976	9,862	35,277,472	9,699	226,772	.....	33
136,985	3,875	2,735	300	1,080	1,355	5,521,786	2,755	16,565	7	34
61,575	1,778	989	583	182	224	2,545,510	1,349	1,100	.....	35
260,168	9,720	6,037	350	927	4,760	13,487,582	6,801	32,661	282	36
144,965	4,175	2,758	45	1,588	1,125	5,732,525	3,094	13,190	.....	37
547,997	12,140	7,203	.....	4,813	2,390	15,105,460	10,876	7,600	15	38
337,634	9,825	10,107	205	8,664	1,238	15,626,380	6,139	2,400	.....	39
1,070,069	36,440	25,133	2,997	843	21,293	34,305,978	7,188	353,646	187	40
403,246	14,548	10,393	1,402	1,362	7,629	17,484,135	3,640	108,521	.....	41
788,196	27,510	18,415	2,734	38	15,643	23,272,308	3,578	286,134	187	42
261,938	8,908	5,852	1,186	299	4,377	10,517,220	1,552	78,623	.....	43
182,060	5,625	3,315	158	357	3,300	6,861,650	1,680	63,388	.....	44
103,559	3,320	2,783	82	612	2,089	5,233,720	1,054	27,365	.....	45
99,813	3,305	2,903	105	448	2,350	4,231,960	1,930	4,124	.....	46
37,749	2,320	1,748	134	451	1,163	1,733,195	1,034	2,533	.....	47
566,318	15,568	9,809	246	67	9,496	16,929,586	3,576	388,080	3,862	48
245,356	3,518	3,454	1,071	208	2,185	5,012,166	1,484	74,834	.....	49
215,957	6,983	4,334	246	22	4,066	6,345,853	763	114,745	237	50
85,710	2,343	2,573	1,036	108	1,399	3,343,021	348	24,837	.....	51
349,311	8,585	5,475	.....	45	5,430	10,583,733	2,813	273,335	3,625	52
158,656	1,175	831	5	100	786	1,669,145	1,136	49,997	.....	53

[1] Includes 2 stations of the "25,000 but under 100,000" group in 1902.
[4] Includes 1 station of the "500,000 and over" group in 1907.
[5] Includes 2 stations of the "25,000 but under 100,000" group in 1907, and 1 station of this group in 1902.

Digitized by Google

Nearly nine-tenths of the municipal stations are located in places for which they supply the entire electric current used, and the statistics for these stations, by geographic divisions, are presented in Table 18.

TABLE 18.—MUNICIPAL CENTRAL ELECTRIC STATIONS WHICH SUPPLY THE ENTIRE ELECTRIC SERVICE IN THE CITIES WHERE LOCATED, BY GEOGRAPHIC DIVISIONS: 1907 AND 1902.

	Census.	Total.	DIVISION.				
			North Atlantic.	South Atlantic.	North Central.	South Central.	Western.
Number of stations	1907	1,114	123	143	658	152	38
	1902	732	93	65	476	72	26
Cost of construction and equipment	1907	$27,310,126	$5,259,164	$3,602,972	$14,117,689	$3,485,495	$844,806
	1902	$15,369,382	$3,121,983	$1,043,002	$8,963,636	$1,203,393	$1,037,368
Gross income	1907	$9,762,111	$1,452,700	$1,396,523	$5,273,998	$1,369,437	$269,453
	1902	$4,923,196	$770,903	$372,983	$2,985,836	$473,597	$319,877
Electric service	1907	$9,419,223	$1,416,548	$1,354,603	$5,047,744	$1,338,200	$262,128
	1902	$4,814,568	$756,655	$367,300	$2,916,827	$461,659	$312,127
Lighting	1907	$9,026,172	$1,331,363	$1,305,739	$4,876,268	$1,274,062	$238,740
	1902	$4,741,735	$741,502	$366,639	$2,889,183	$450,177	$294,234
Commercial	1907	$6,204,396	$805,934	$906,681	$3,371,141	$929,799	$190,841
	1902	$2,925,788	$389,206	$199,029	$1,827,478	$304,860	$205,215
Public	1907	$2,821,776	$525,429	$399,058	$1,505,127	$344,263	$47,899
	1902	$1,815,947	$352,296	$167,610	$1,061,705	$145,317	$89,019
Stationary motors	1907	$342,865	$79,634	$45,128	$151,706	$45,481	$20,916
	1902	$63,880	$12,638	$661	$24,098	$11,082	$15,401
All other	1907	$50,186	$5,551	$3,736	$19,770	$18,657	$2,472
	1902	$8,953	$2,515	.....	$3,546	$400	$2,492
All other sources	1907	$342,888	$36,152	$41,920	$226,254	$31,237	$7,325
	1902	$108,628	$14,248	$5,683	$69,009	$11,938	$7,750
Total expenses	1907	$6,573,242	$930,274	$890,831	$3,674,883	$909,922	$167,332
	1902	$3,567,352	$595,586	$267,091	$2,120,088	$342,275	$242,312
Cost of supplies and materials[1]	1907	$3,649,243	$479,940	$509,973	$2,062,699	$510,027	$86,604
	1902	$1,884,539	$281,178	$150,187	$1,136,979	$186,321	$129,874
Miscellaneous expenses	1907	$558,630	$105,895	$50,764	$309,320	$78,296	$14,355
	1902	$327,980	$79,340	$16,559	$179,925	$25,053	$27,103
Salaries and wages	1907	$2,365,369	$344,439	$330,094	$1,302,864	$321,599	$66,373
	1902	$1,354,833	$235,068	$100,345	$803,184	$130,901	$85,335
Primary-power plant: Total horsepower capacity[2]	1907	241,028	37,914	32,037	134,554	31,270	5,253
	1902	124,362	22,317	8,825	78,124	11,653	3,443
Generating plant: Kilowatt capacity of dynamos	1907	159,265	25,087	20,157	89,558	21,069	3,394
	1902	85,122	15,155	5,747	52,526	8,264	3,430
Output of stations, kilowatt hours	1907	196,435,621	27,540,654	25,600,947	110,478,858	28,335,699	4,479,463
	1902	148,913,431	21,820,641	11,717,107	95,812,332	14,611,775	4,951,576
Lamps wired for service: Arc	1907	40,965	6,001	5,588	24,370	4,568	438
	1902	28,631	5,126	2,334	17,570	2,201	1,400
Incandescent[3]	1907	3,363,195	580,424	369,264	1,967,470	336,496	89,541
	1902	1,465,582	259,577	78,779	947,946	104,446	74,834
Other varieties—Nernst, vacuum, vapor, etc.[4]	1907	3,753	770	42	2,570	167	204

[1] Includes cost of fuel amounting to $2,517,986 in 1907 and $1,124,403 in 1902.
[2] Includes capacity of auxiliary engines amounting to 1,134 horsepower in 1907 and 525 horsepower in 1902.
[3] The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.
[4] Not reported separately in 1902.

Large increases are shown for all but the Western division. In this division decreases are found for nearly every item, but these decreases are only apparent and not real. A number of municipal stations which were included in this class in 1902 could not properly be included in 1907 because in the latter year they did not supply the sole electric service to the places in which they were located. This was particularly the case in the states of California and Washington. If all the stations in these 2 states which were included in 1902 had also been included in 1907, uniform gains would have been shown for the Western division also.

It is noteworthy that proportionately larger gains were reported for commercial lighting than for public lighting, and for incandescent lamps than for arc lamps. This was true for all geographic divisions. Compared with the increases for most of the items the output of stations in kilowatt hours shows small percentages of gain. This is in large part due to the difference in the stations included at the respective censuses, previously referred to, and to the fact that a somewhat larger amount was expended in 1907 than in 1902 for power purchased, the difference amounting to upward of $70,000.

The statistics for municipal stations located in places where they furnished only a part of the electric service are shown, by geographic divisions, in Table 19.

Digitized by Google

TABLE 19.—MUNICIPAL CENTRAL ELECTRIC STATIONS WHICH DO NOT SUPPLY THE ENTIRE ELECTRIC SERVICE IN THE CITIES WHERE LOCATED, BY GEOGRAPHIC DIVISIONS: 1907 AND 1902.

	Census.	Total.	DIVISION.				
			North Atlantic.	South Atlantic.	North Central.	South Central.	Western.
Number of stations	1907	138	27	15	69	14	13
	1902	83	10	10	52	9	2
Cost of construction and equipment	1907	$15,569,321	$2,579,831	$473,070	$8,837,473	$773,626	$2,905,321
	1902	$6,651,091	$820,156	$518,936	$4,908,609	$378,993	$24,397
Gross income	1907	$4,249,888	$855,382	$224,786	$2,129,017	$271,171	$769,532
	1902	$2,041,909	$318,628	$210,179	$1,411,673	$92,549	$8,880
Electric service	1907	$4,195,211	$849,958	$219,440	$2,095,008	$270,832	$759,973
	1902	$2,022,288	$318,628	$210,179	$1,392,052	$92,549	$8,880
Lighting	1907	$4,014,091	$777,665	$214,132	$2,071,438	$255,757	$695,099
	1902	$2,007,128	$309,618	$204,733	$1,391,348	$92,549	$8,880
Commercial	1907	$1,190,591	$230,530	$78,815	$323,702	$38,758	$518,786
	1902	$182,674	$12,250	$88,901	$76,130	$5,393	.....
Public	1907	$2,823,500	$547,135	$135,317	$1,747,736	$216,999	$176,313
	1902	$1,824,454	$297,368	$115,832	$1,315,218	$87,156	$8,880
Stationary motors	1907	$173,508	$70,152	$5,284	$20,022	$15,075	$62,975
	1902	$6,660	$510	$5,446	$704	.....	.....
All other	1907	$7,612	$2,141	$24	$3,548	.....	$1,899
	1902	$8,500	$8,500	.....	.....	.....	.....
All other sources	1907	$54,677	$5,424	$5,346	$34,009	$339	$9,559
	1902	$19,621	.....	.....	$19,621	.....	.....
Total expenses	1907	$2,593,946	$476,541	$160,771	$1,397,501	$160,147	$398,986
	1902	$1,173,830	$172,767	$118,321	$818,717	$60,971	$3,054
Cost of supplies and materials[1]	1907	$1,318,444	$225,857	$95,899	$725,162	$78,919	$192,607
	1902	$537,752	$72,814	$59,811	$374,097	$29,969	$1,061
Miscellaneous expenses	1907	$155,856	$42,217	$7,265	$70,935	$16,526	$18,913
	1902	$111,189	$23,356	$9,366	$73,902	$4,412	$153
Salaries and wages	1907	$1,119,646	$208,467	$57,607	$601,404	$64,702	$187,466
	1902	$524,889	$76,597	$49,144	$370,718	$26,590	$1,840
Primary-power plant: Total horsepower capacity[2]	1907	80,323	18,666	4,505	41,667	5,170	10,315
	1902	35,666	4,340	3,585	24,771	2,895	75
Generating plant: Kilowatt capacity of dynamos	1907	49,751	10,238	2,602	26,432	4,064	6,415
	1902	28,258	2,730	2,722	20,643	2,129	34
Output of stations, kilowatt hours	1907	93,027,167	21,320,984	4,699,450	48,526,331	6,030,279	12,450,123
	1902	46,991,006	6,649,005	5,355,864	32,053,189	2,872,360	60,590
Lamps wired for service: Arc	1907	41,975	6,319	1,941	27,957	2,620	3,138
	1902	22,164	2,720	1,896	16,025	1,439	84
Incandescent[3]	1907	689,253	123,210	33,689	216,665	17,150	298,539
	1902	111,869	12,635	28,985	66,174	4,075	.....
Other varieties—Nernst, vacuum, vapor, etc.[4]	1907	5,117	379	21	1,039	20	3,658

[1] Includes cost of fuel amounting to $714,797 in 1907 and $321,421 in 1902.
[2] Includes capacity of auxiliary engines amounting to 370 horsepower in 1907 and 310 horsepower in 1902.
[3] The number of incandescent lamps was largely an estimate and, although mostly reported on a 16-candlepower basis, embraces a considerable number ranging from 2 to 50 candlepower.
[4] Not reported separately in 1902.

The number of stations shown in Table 19 is only about 10 per cent of the total for municipal stations for both 1907 and 1902, but the proportions of the totals for several other leading items were much greater. For 1907 these were as follows: Gross income, 30.3 per cent; sale of current, 30.8 per cent; expenses, 28.3 per cent; primary horsepower, 25 per cent; kilowatt capacity of dynamos, 23.8 per cent; output of stations, kilowatt hours, 32.1 per cent; number of arc lamps, 50.6 per cent; and number of incandescent lamps, 17 per cent. The corresponding proportions for 1902 were: Gross income, 29.3 per cent; sale of current, 29.6 per cent; expenses, 24.8 per cent; primary horsepower, 22.3 per cent; kilowatt capacity of dynamos, 24.9 per cent; output of stations, kilowatt hours, 24 per cent; number of arc lamps, 43.6 per cent; and number of incandescent lamps, 7.1 per cent. A comparison of Tables 18 and 19 shows that public lighting occupied a far larger proportionate place in the business of the municipal stations included in the latter table than in that of those included in Table 18. In Table 19 the income from public lighting in 1907 constituted 66.4 per cent of the total income and in Table 18 only 28.9 per cent. This difference between the two classes of municipal stations is also reflected in their varying proportions of arc lamps, which find their chief use in public lighting of streets and parks. In Table 19 the arc lamps constituted 5.7 per cent of all lamps and in Table 18 only 1.2 per cent. As the primary object of municipal stations in places where they do not supply the sole electric service is probably in most cases the lighting of streets and parks, incandescent lighting for municipal stations would chiefly be confined to places where there were no commercial stations.

Digitized by Google

In the following tabular statement the relative importance of the two classes of municipal stations in the various geographic divisions is shown on the basis of income reported:

Municipal central electric stations that render the entire electric service and those that do not—Per cent distribution of income, by geographic divisions: 1907.

DIVISION.	Municipal stations which render the entire service.	Municipal stations which render only part of the service.
Total	100.0	100.0
North Atlantic	14.9	20.1
South Atlantic	14.3	5.3
North Central	54.0	50.1
South Central	14.0	6.4
Western	2.8	18.1

As indicated by the income, the North Central division reported slightly more than half of the municipal central-station industry for both classes of stations. The municipal stations which render the entire electrical service were, however, proportionately stronger here. In the other geographic divisions wide differences appear in the relative importance of the two classes of municipal stations. In the South Atlantic and the South Central, as in the North Central, the municipal stations which render the entire service were proportionately stronger—considerably more than twice as strong. In the North Atlantic and the Western divisions, on the other hand, the municipal stations which render only part of the service were proportionately stronger, and in the case of the Western division more than six times as strong.

Digitized by Google

CHAPTER III.

POWER EQUIPMENT.

Primary-power equipment of central stations and electric railways.—The equipment of the primary-power plants as reported to the Bureau of the Census consists of the number and horsepower of the steam engines, steam turbines, gas engines, water wheels, and auxiliary engines. With the exception of the auxiliary engines, which represent the power used within the station to operate pumps, etc., these machines are necessarily closely allied to the equipment of the generating plant. In a few instances the primary-power plant and the electric generators are conducted under independent ownership, but the two classes of equipment are so generally interdependent that the statistics for them are associated in various tables throughout the report. The totals for the primary machines in central stations and electric-railway plants are given in Table 20.

TABLE 20.—CENTRAL ELECTRIC STATIONS AND ELECTRIC RAILWAYS—NUMBER AND HORSEPOWER OF THE PRIMARY-POWER MACHINES, BY KIND OF POWER: 1907 AND 1902.

KIND OF POWER.	TOTAL.		CENTRAL STATIONS.		ELECTRIC RAILWAYS.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Central stations.	Electric railways.
Total:									
Number	14,635	10,661	10,998	7,850	3,637	2,811	37.3	40.1	29.4
Horsepower	6,618,011	3,204,333	4,098,188	1,845,048	2,519,823	1,359,285	106.5	122.1	85.4
Steam engines:									
Number	9,088	8,266	6,829	5,930	2,259	2,336	9.9	15.2	[1]3.3
Horsepower	3,642,819	2,678,074	1,810,040	1,379,941	1,832,779	1,298,133	36.0	31.2	41.2
Steam turbines:									
Number	629	[2]	377	[2]	252	[2]	.....	.....	.....
Horsepower	1,352,814	[2]	817,410	[2]	535,404	[2]	.....	.....	.....
Gas engines:									
Number	504	180	463	165	41	15	180.0	180.6	173.3
Horsepower	72,163	14,106	55,828	12,181	16,335	1,925	411.6	358.3	748.3
Water wheels:									
Number	2,709	1,549	2,481	1,390	228	159	74.9	78.5	43.4
Horsepower	1,441,048	487,625	1,349,087	438,472	91,961	49,153	195.5	207.7	87.1
Auxiliary engines:									
Number	1,705	666	848	365	857	301	156.0	132.3	185.4
Horsepower	109,167	24,528	65,823	14,454	43,344	10,074	345.1	355.4	330.3

[1] Decrease.

[2] In 1902 steam turbines were included with steam engines.

The combined horsepower of the engines and water wheels used to operate the electric machines in the central stations and railway plants more than doubled during the five years ending with 1907. The power plants of the central stations show the greater gain, representing 57.6 per cent of the total horsepower in 1902 and 61.9 per cent in 1907.

While steam is the most important primary power in both branches of the industry, its lead is greatest in the railway plants, where at both censuses it formed about 95 per cent of all the primary power reported. It was in this kind of primary power that the electric railways showed their largest proportion of the total, namely, 47.4 and 48.5 per cent, respectively, in 1907 and 1902. In respect to steam engines alone the electric railways showed a marked relative gain over 1902, but having 81,808 less horsepower than the central stations in that year as compared with an excess of 22,739 horsepower in 1907. The true measure of the comparative importance of steam power in the two branches of the electrical industry, however, is furnished by a comparison of the totals for both steam engines and steam turbines, and this shows that, as compared with electric railways, the central stations reported an excess of 259,267 steam horsepower in 1907 and 81,808 in 1902.

The horsepower of gas engines, although forming but a small proportion of the total primary power, showed a decided increase in both branches of the electrical industry, but the proportion was greatest for the electric railways, this particular kind of power having increased from 13.6 per cent in 1902 to 22.6 per cent in 1907. Water power has developed more rapidly as connected with the central stations than with the electric railways, the proportion of the total reported by the former having increased from 89.9 per cent in 1902 to 93.6 per cent in 1907.

CENTRAL STATIONS.

Engines and water wheels.—Table 21 gives statistics of the primary-power equipment of commercial and municipal central stations for 1907 and 1902 and shows the percentages of increase.

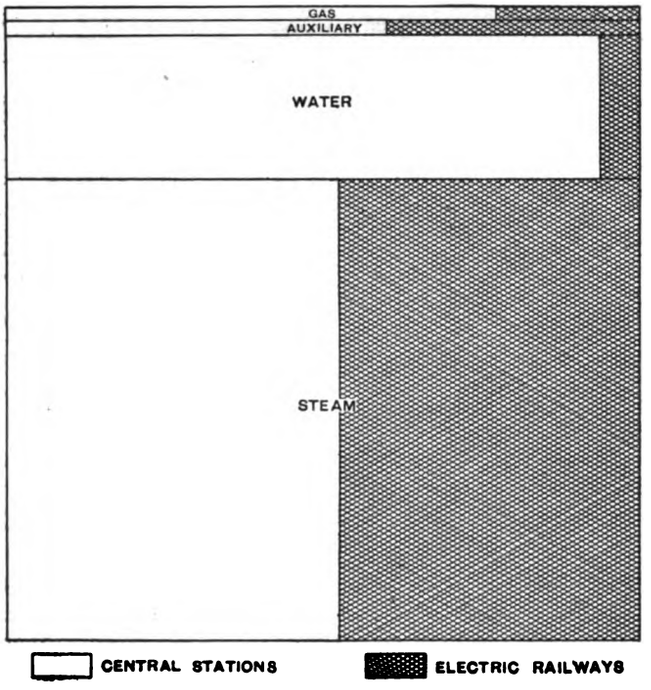
Digitized by Google

TABLE 21.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER AND HORSEPOWER OF THE PRIMARY-POWER MACHINES, BY KIND OF POWER: 1907 AND 1902.

KIND OF POWER.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Total:									
Number	10,998	7,850	8,981	6,654	2,017	1,196	40.1	35.0	68.6
Horsepower	4,008,188	1,845,048	3,776,837	1,685,020	321,351	160,028	122.1	124.1	100.8
Steam engines:									
Number	6,829	5,930	5,144	4,870	1,685	1,060	15.2	5.6	59.0
Horsepower	1,810,040	1,379,941	1,546,007	1,232,923	264,033	147,018	31.2	25.4	79.6
Steam turbines:									
Number	377	(1)	348	(1)	29	(1)	.....	.....	.....
Horsepower	817,410	(1)	798,025	(1)	19,385	(1)	.....	.....	.....
Gas engines:									
Number	463	165	385	147	78	18	180.6	161.9	333.3
Horsepower	55,828	12,181	49,746	11,224	6,082	957	358.3	343.2	535.5
Water wheels:									
Number	2,481	1,390	2,328	1,308	153	82	78.5	78.0	86.6
Horsepower	1,349,087	438,472	1,318,740	427,254	30,347	11,218	207.7	208.7	170.5
Auxiliary engines:									
Number	848	365	776	329	72	36	132.3	135.9	100.0
Horsepower	65,823	14,454	64,319	13,619	1,504	835	355.4	372.3	83.7

[1] In 1902 steam turbines were included with steam engines.

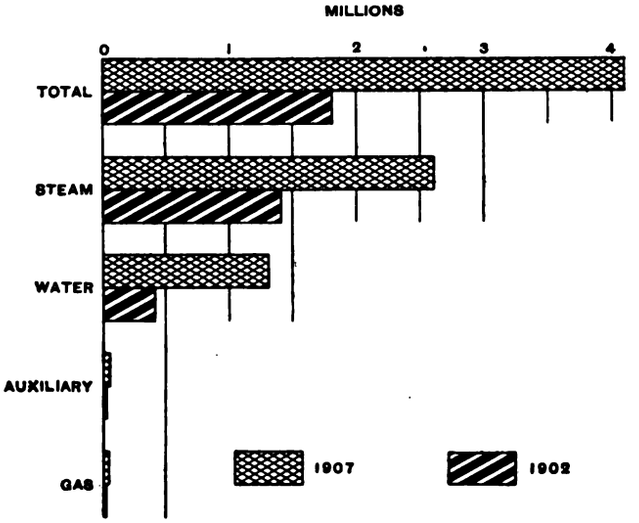
DIAGRAM 1.—*Central stations and electric railways, by character of primary power: 1907.*



In 1907 the primary machines of the central stations averaged 869 horsepower per station as compared with 510 horsepower in 1902, an increase of 359 horsepower, or 70.4 per cent. The commercial stations averaged 1,091 horsepower in 1907 and 601 horsepower in 1902, showing an increase of 490 horsepower, or 81.5 per cent; while the municipal stations averaged 257 horsepower in 1907 and 196 horsepower in 1902, showing an increase of 61 horsepower, or 31.1 per cent.

Steam has contributed more than any other kind of power to the great increase, 1,247,509 horsepower, in the primary power of central stations, and the steam turbine, which was first reported separately in this industry at the census of 1907, has become a very important factor in the electrical generating equipment. Water is used as the primary power in a constantly increasing number of stations, and the power of the wheels increased by 910,615 horsepower during the five years ending with 1907. Although the greatest absolute increase was shown for steam power, in percentage of increase, it was surpassed by both gas and water power. The percentages are: Steam power, 90.4 per cent; water power, 207.7 per cent; and gas power, 358.3 per cent.

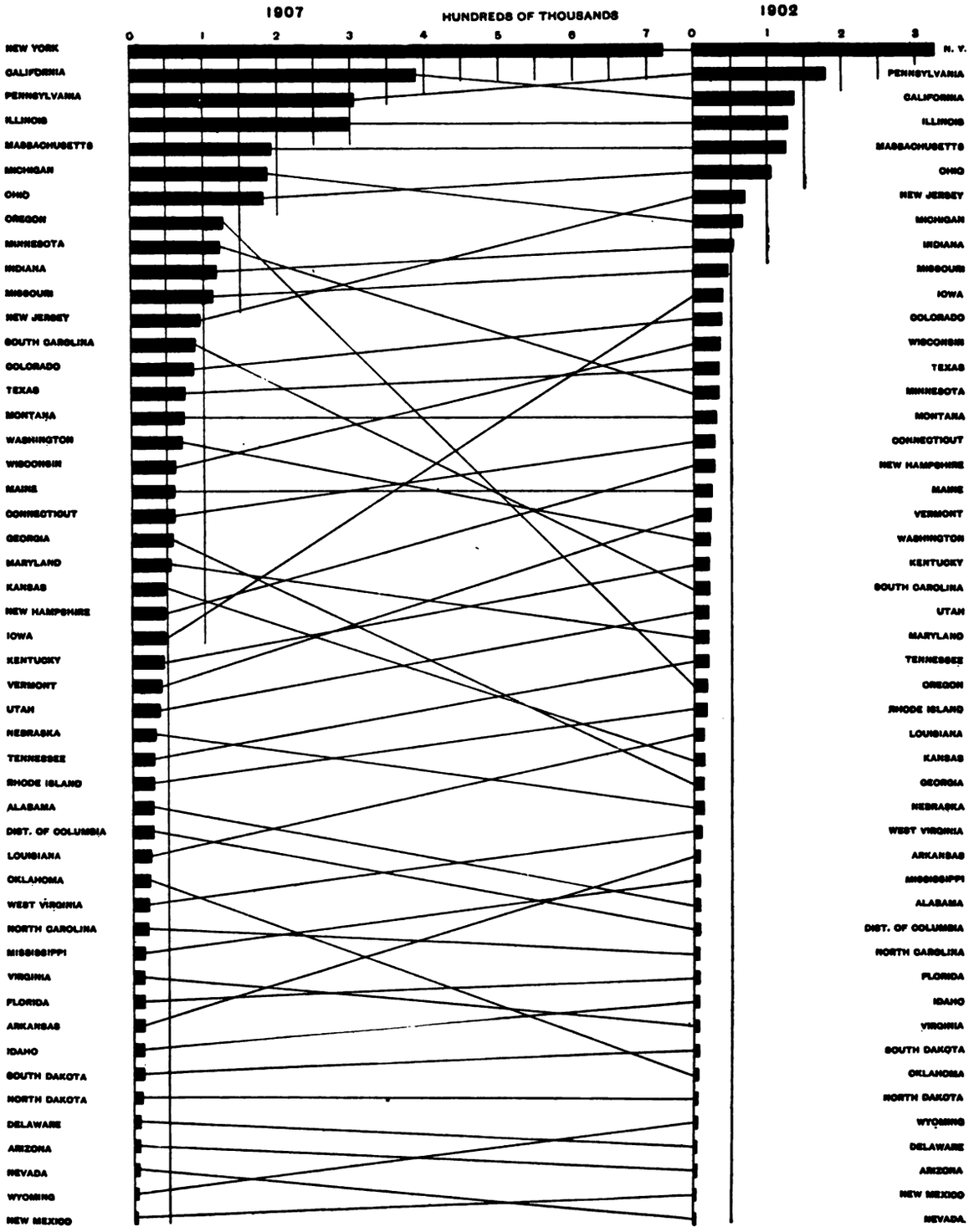
DIAGRAM 2.—*Central stations, by character of primary power: 1907 and 1902.*



Of the two classes of stations the commercial shows by far the greater amount of power and the larger increase since 1902. In 1907 their equipment represented 92.2 per cent of the total primary power, the proportion having increased from 91.3 per cent in 1902. Thus, while the municipal electric stations, as compared with many industries, have a large motive-power equipment, it forms but a small proportion (7.8 per cent) of the primary power used for the generation of electricity in central stations.

Digitized by Google

DIAGRAM 3.—CENTRAL ELECTRIC STATIONS—PRIMARY POWER, BY STATES, ARRANGED IN ORDER OF THEIR RELATIVE IMPORTANCE: 1907 AND 1902.



Digitized by Google

Table 22 shows the per cent distribution, by kind of power, of the primary-power equipment of commercial and municipal stations for 1907 and 1902.

TABLE 22.—*Commercial and municipal central electric stations—Per cent distribution, by kind of primary-power machines: 1907 and 1902.*

KIND OF POWER.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total:						
Number	100.0	100.0	100.0	100.0	100.0	100.0
Horsepower	100.0	100.0	100.0	100.0	100.0	100.0
Steam engines:						
Number	62.1	75.5	57.3	73.2	83.5	88.6
Horsepower	44.2	74.8	40.9	73.2	82.2	91.9
Steam turbines:						
Number	3.4	(1)	3.9	(1)	1.4	(1)
Horsepower	19.9	(1)	21.1	(1)	6.0	(1)
Gas engines:						
Number	4.2	2.1	4.3	2.2	3.9	1.5
Horsepower	1.4	0.7	1.3	0.7	1.9	0.6
Water wheels:						
Number	22.6	17.7	25.9	19.7	7.6	6.9
Horsepower	32.9	23.8	34.9	25.4	9.4	7.0
Auxiliary engines:						
Number	7.7	4.6	8.6	4.9	3.6	3.0
Horsepower	1.6	0.8	1.7	0.8	0.5	0.5

[1] In 1902 steam turbines were included with steam engines.

Steam engines furnished the largest proportion of horsepower for both the commercial and the municipal stations, but for each of the two classes of stations their relative importance has decreased considerably since 1902, while that of the water wheels and gas engines has increased. If a division of the primary power, including auxiliary power, be made into the three classes—steam, gas, and water—it is found that of the total power in central stations in 1907, 65.7 per cent was steam; 1.4 per cent, gas; and 32.9 per cent, water. The corresponding proportions for 1902 were: Steam, 75.6 per cent; gas, seven-tenths of 1 per cent; and water, 23.8 per cent. Of the proportion for steam in 1907, the commercial stations reported 58.8 per cent of the total primary power and the municipal stations 6.9 per cent. The corresponding proportions in 1902 were 67.6 per cent and 8 per cent, respectively.

Steam engines and steam turbines.—Inasmuch as steam turbines were not reported separately in 1902, they are, for comparative purposes, combined with steam engines for 1907 in Tables 23 and 24, which give detailed statistics of the steam-power equipment of commercial and municipal central stations for 1907 and 1902.

TABLE 23.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—STEAM ENGINES AND STEAM TURBINES, BY HORSEPOWER CAPACITY: 1907 AND 1902.

CLASS OF ENGINES.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Total:									
Number	7,206	5,930	5,492	4,870	1,714	1,060	21.5	12.8	61.7
Horsepower	2,627,450	1,379,941	2,344,032	1,232,923	283,418	147,018	90.4	90.1	92.8
500 horsepower and under:									
Number	6,248	5,451	4,584	4,407	1,664	1,044	14.6	4.0	59.4
Horsepower	1,035,583	849,336	794,205	715,418	241,378	133,918	21.9	11.0	80.2
Over 500 but under 1,000 horsepower:									
Number	498	278	460	266	38	12	79.1	72.9	216.7
Horsepower	345,158	193,570	318,818	184,670	26,340	8,900	78.3	72.6	196.0
1,000 but under 2,000 horsepower:									
Number	249	149	239	145	10	4	67.1	64.8	150.0
Horsepower	316,588	187,485	306,188	183,285	10,400	4,200	68.9	67.1	147.6
2,000 but under 5,000 horsepower:									
Number	148	52	146	52	2	.....	184.6	180.8	.....
Horsepower	407,695	149,550	402,395	149,550	5,300	.....	172.6	169.1	.....
5,000 horsepower and over:									
Number	63	(1)	63	(1)	.....	.....	.....	.....	.....
Horsepower	522,426	(1)	522,426	(1)	.....	.....	.....	.....	.....

[1] Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

The figures in Tables 23 and 24 show that the greatest increases have taken place in the horsepower of the largest types of steam engines. Of the total steam power reported for 1907, 35.4 per cent was represented by machines with a capacity of 2,000 horsepower or over, while machines of this type represented only 10.8 per cent of the steam power reported for 1902. In 1902, of the total steam power, 61.5 per cent was in the class of "500 horsepower and under," and in 1907 the proportion had decreased to 39.4 per cent. The commercial stations naturally made the most marked gains in the large units of power, increasing from 12.1 per cent for the class of 2,000 and over in 1902 to 39.5 per cent in 1907, and decreasing from 58 per cent for the class of 500 or under in 1902 to 33.9 per cent in 1907. The municipal stations, although showing no marked changes in the relative proportions of the several classes, manifest a tendency toward the larger units of steam power.

Digitized by Google

TABLE 24.—*Commercial and municipal central electric stations—Per cent distribution, by number and horsepower capacity of steam engines and steam turbines: 1907 and 1902.*

CLASS OF ENGINES.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total:						
Number	100.0	100.0	100.0	100.0	100.0	100.0
Horsepower	100.0	100.0	100.0	100.0	100.0	100.0
500 horsepower and under:						
Number	86.7	91.9	83.5	90.5	97.1	98.5
Horsepower	39.4	61.5	33.9	58.0	85.2	91.1
Over 500 but under 1,000 horsepower:						
Number	6.9	4.7	8.4	5.5	2.2	1.1
Horsepower	13.1	14.0	13.6	15.0	9.3	6.1
1,000 but under 2,000 horsepower:						
Number	3.5	2.5	4.4	3.0	0.6	0.4
Horsepower	12.0	13.6	13.1	14.9	3.7	2.9
2,000 but under 5,000 horsepower:						
Number	2.1	0.9	2.7	1.1	0.1	.....
Horsepower	15.5	10.8	17.2	12.1	1.9	.....
5,000 horsepower and over:						
Number	0.9	(1)	1.1	(1)	.....	.....
Horsepower	19.9	(1)	22.3	(1)	.....	.....

[1] Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

There were only 3 states—Nevada, South Carolina, and Utah—for which a smaller amount of primary steam power was reported in 1907 than in 1902. While only 9,964 steam horsepower was reported for these states in 1907 and 12,990 in 1902, it is interesting to note that for each state there was an increase in water power far greater than the decrease in steam power. In each of the following states the steam power reported for 1907 exceeded 100,000 horsepower: New York, 410,007 horsepower; Illinois, 286,958; Pennsylvania, 258,163; Ohio, 170,251; Massachusetts, 169,617; California, 133,299; and Missouri, 102,044. The total for these states amounted to 1,530,339 horsepower, or 58.2 per cent of the total steam power for all states.

The increase in the number and importance of the steam turbines makes it desirable to segregate the statistics for the two kinds of engines operated by steam, and Tables 25 and 26 show the totals and percentages for engines exclusive of steam turbines. The statistics for 1902, however, include the figures for a comparatively small number of steam turbines, because they were not deemed of sufficient importance to be reported separately for that year, and to this extent the comparison of the figures for the two census years is vitiated.

TABLE 25.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER AND HORSEPOWER OF STEAM ENGINES, EXCLUSIVE OF STEAM TURBINES: 1907 AND 1902.

CLASS OF ENGINES.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Total:									
Number	6,829	5,930	5,144	4,870	1,685	1,060	15.2	5.6	59.0
Horsepower	1,810,040	1,379,941	1,546,007	1,232,923	264,033	147,018	31.2	25.4	79.6
500 horsepower and under:									
Number	6,183	5,451	4,535	4,407	1,648	1,044	13.4	2.9	57.9
Horsepower	1,018,566	849,336	781,673	715,418	236,893	133,918	19.9	9.3	76.9
Over 500 but under 1,000 horsepower:									
Number	375	278	342	266	33	12	34.9	28.6	175.0
Horsepower	259,478	193,570	236,638	184,670	22,840	8,900	34.0	28.1	156.6
1,000 but under 2,000 horsepower:									
Number	182	149	178	145	4	4	22.1	22.8	.....
Horsepower	230,216	187,485	225,916	183,285	4,300	4,200	22.8	23.3	2.4
2,000 but under 5,000 horsepower:									
Number	70	52	70	52	.....	.....	.....	.....	.....
Horsepower	186,280	149,550	186,280	149,550	.....	.....	.....	.....	.....
5,000 horsepower and over:									
Number	19	(1)	19	(1)	.....	.....	.....	.....	.....
Horsepower	115,500	(1)	115,500	(1)	.....	.....	.....	.....	.....

[1] Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

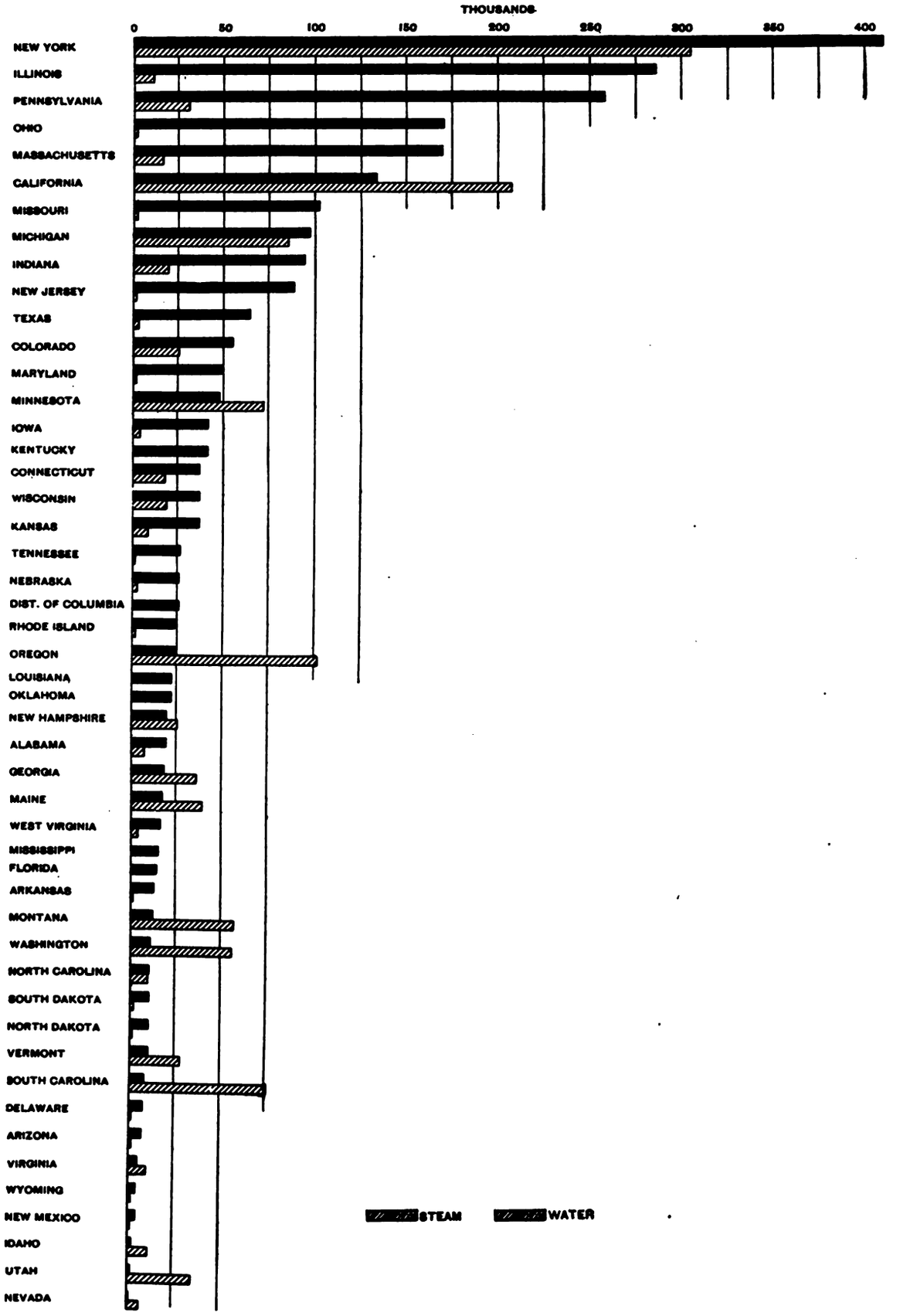
While a considerable increase took place in the horsepower of the smaller engines in both classes of stations, it has not been sufficient to overcome the increase in the larger units. Therefore the relative importance of the engines of "500 horsepower and under" decreased from 61.5 per cent of the total in 1902 to 56.3 per cent in 1907, the greatest relative decrease, from 58 per cent to 50.6 per cent, occurring in the commercial stations, which contain all of the large engines.

As would naturally be expected, the municipal stations show no large steam engines. There were no machines of more than 2,000 horsepower reported for such stations at either census, and only 4 that had an indicated horsepower of 1,000 and over. As a rule the municipal stations are small, and therefore contain a large proportion of the small machines.

Little change was shown in the proportion of engines of "Over 500 but under 1,000 horsepower," 14.3 per cent in 1907 and 14 per cent in 1902, but there was a decline in the proportion of engines of "1,000 but under 2,000 horsepower," from 13.6 per cent in 1902 to 12.7 per cent in 1907. As already indicated, a decided increase was manifest in the proportion of engines of over 2,000 horsepower, from 10.8 per cent in 1902 to 16.7 per cent in 1907.

Digitized by Google

DIAGRAM 4.—CENTRAL ELECTRIC STATIONS—STEAM AND WATER POWER, BY STATES, ARRANGED IN ORDER OF THEIR RELATIVE IMPORTANCE: 1907.



Digitized by Google

TABLE 26.—*Commercial and municipal central electric stations—Per cent distribution, by number and horsepower capacity of steam engines, exclusive of steam turbines: 1907 and 1902.*

CLASS OF ENGINES.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total:						
Number	100.0	100.0	100.0	100.0	100.0	100.0
Horsepower	100.0	100.0	100.0	100.0	100.0	100.0
500 horsepower and under:						
Number	90.5	91.9	88.2	90.5	97.8	98.5
Horsepower	56.3	61.5	50.6	58.0	89.7	91.1
Over 500 but under 1,000 horsepower:						
Number	5.5	4.7	6.6	5.5	2.0	1.1
Horsepower	14.3	14.0	15.3	15.0	8.7	6.1
1,000 but under 2,000 horsepower:						
Number	2.7	2.5	3.5	3.0	0.2	0.4
Horsepower	12.7	13.6	14.6	14.9	1.6	2.9
2,000 but under 5,000 horsepower:						
Number	1.0	0.9	1.4	1.1	.....	.....
Horsepower	10.3	10.8	12.0	12.1	.....	.....
5,000 horsepower and over:						
Number	0.3	(1)	0.4	(1)	.....	.....
Horsepower	6.4	(1)	7.5	(1)	.....	.....

[1] Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

Since all engines with an indicated horsepower of 2,000 or over were reported as a single group at the census of 1902, it is impracticable to determine the number and horsepower of the machines of 5,000 and over in operation in that year to compare with those reported in 1907. At the latter census these engines were distributed as follows: New York, 11 engines with 60,500 horsepower; California, 5 with 34,500; Pennsylvania, 1 with 8,000; Maryland, 1 with 7,500; and Illinois, 1 with 5,000.

Steam turbines.—These engines appear to be admirably adapted to central-station work, and although a number of engines of this type of small horsepower capacity were reported, it is evident from the statistics in Table 27 that the majority were of large horsepower and especially fitted to meet the requirements of large centers of distribution.

The municipal stations contained comparatively few steam turbines, the majority of which (55.2 per cent) were of the smaller type. The turbines of less than 2,000 horsepower, as shown in Table 27, formed 72.7 per cent of the total power of all these engines in the municipal stations and but 22 per cent of the power of those in the commercial stations. In commercial stations the large engines, those having over 2,000 horsepower, represented 78.1 per cent of the total turbine power. Practically one-half of the horsepower of the steam turbines was in units of 5,000 and over. The extent to which the steam turbine predominates among the machines of this largest capacity is indicated by the fact that in 1907 there were 44 turbines in this class, with a total of 406,926 horsepower, as compared with 19 steam engines of other types of 115,500 horsepower and 55 water wheels of 339,800 horsepower. Of the total for all kinds of primary power, excluding auxiliary engines, the steam turbine furnished 20.3 per cent as compared with 44.9 per cent for other classes of steam engines and 33.5 per cent for water wheels.

TABLE 27.—*Commercial and municipal central electric stations—Number and horsepower of steam turbines, by horsepower capacity, with per cent distribution: 1907.*[1]

CLASS OF STEAM TURBINES.	Total.	Commercial.	Municipal.	PER CENT DISTRIBUTION.		
				Total.	Commercial.	Municipal.
Total:						
Number	377	348	29	100.0	100.0	100.0
Horsepower	817,410	798,025	19,385	100.0	100.0	100.0
500 horsepower and under:						
Number	65	49	16	17.2	14.1	55.2
Horsepower	17,017	12,532	4,485	2.1	1.6	23.1
Over 500 but under 1,000 horsepower:						
Number	123	118	5	32.6	33.9	17.2
Horsepower	85,680	82,180	3,500	10.5	10.3	18.1
1,000 but under 2,000 horsepower:						
Number	67	61	6	17.8	17.5	20.7
Horsepower	86,372	80,272	6,100	10.6	10.1	31.5
2,000 but under 5,000 horsepower:						
Number	78	76	2	20.7	21.8	6.9
Horsepower	221,415	216,115	5,300	27.1	27.1	27.3
5,000 horsepower and over:						
Number	44	44	.....	11.7	12.6	.....
Horsepower	406,926	406,926	.....	49.8	51.0	.....

[1] Comparison with 1902 impracticable, since in that year steam turbines were included with steam engines.

Steam turbines were reported as in use in some of the central stations of all the states and territories, except Virginia, North Carolina, South Carolina, North Dakota, Idaho, Utah, Nevada, and New Mexico. In all these states together only 41,130 steam horsepower was reported for the stations, and it is evident that water power, of which 147,979 horsepower was reported, was more economical, or that the business did not justify or require the installation of turbines.

Nearly one-half (48.2 per cent) of the horsepower of the steam turbines was contained in 3 states—New York, Illinois, and Massachusetts. New York alone reported 24.9 per cent of this class of power, while as between steam engines and steam turbines in that state the latter represented 49.7 per cent of their total horsepower. Of the total steam power in Illinois, 48.3 per cent was reported for steam turbines, while of the total in Massachusetts, the proportion contributed by steam turbines was considerably less, 30.3 per cent. Although steam turbines were in use in 187 stations, in only 18 were they the sole primary power.

That the steam turbine is specially adapted to large centers of distribution will be seen from Table 28.

More than three-fifths of the horsepower reported for steam turbines was found in the 14 cities named, and their 90 engines showed the enormous average of 5,559 horsepower, as compared with an average of 2,168 for the country as a whole.

Digitized by Google

TABLE 28.—*Central electric stations in selected cities—Number and horsepower of steam turbines: 1907.*

CITY.	Number.	Horsepower.	Per cent distribution.
Total for United States	377	817,410	100.0
Total for selected cities	90	500,335	61.2
New York	22	170,600	20.9
Chicago	10	116,500	14.3
St. Louis	10	38,882	4.8
Boston	3	30,000	3.7
Philadelphia	7	25,468	3.1
Los Angeles	6	25,360	3.1
Cleveland	6	22,000	2.7
Washington	4	21,000	2.6
Baltimore	6	10,200	1.2
Louisville	2	9,000	1.1
Denver	4	8,525	1.0
Indianapolis	5	7,800	1.0
Cincinnati	1	7,500	0.9
Hartford	4	7,500	0.9

Gas engines.—The 463 engines denominated as gas engines in Table 21, with a total of 55,828 horsepower, are composed of 294 gas engines, with 45,330 horsepower; 136 gasoline engines, with 4,313 horsepower; and 33 oil engines, with 6,185 horsepower. These machines were used in 294 stations, of which 180, with 292 engines and a total of 23,487 horsepower, were operated wholly by machines of this class. Of these 180 stations, 137, with 19,532 horsepower, were commercial stations, and 43, with 3,955 horsepower, municipal stations. Although the proportion of the total horsepower in central stations which is represented by the gas engines is comparatively small (1.4 per cent of the total primary power), the number and importance of the gas engines have nevertheless increased largely since 1902. As a rule these engines are of a small type and their use has been confined largely to small plants. Lately, however, a larger type of machine is coming into use, and one commercial station operated 3 gas engines, with a total of 16,200 horsepower, which furnished motive power to operate 3 dynamos of slightly less than 4,000 kilowatts each. The exact size of each engine was not reported on the census schedule, but it appears that the smallest engine in this class shown as connected with a generator is one of 6 horsepower, which operated a 3-kilowatt dynamo. California reported gas engines with a total of 16,585 horsepower, or 29.7 per cent of the total of this class of primary power; Pennsylvania reported 7,469 horsepower; Ohio, 5,628; New York, 3,315; Texas, 3,058; and Wisconsin, 2,079. The horsepower of the gas engines of these 6 states amounted to 38,134 and formed 68.3 per cent of the total horsepower reported for all gas engines in both commercial and municipal stations.

Internal-combustion oil engines.—At the census of 1907, 18 stations reported the use of oil engines of the internal-combustion type, similar in character to the gas engine, with 6,185 horsepower; and 10 stations, with 18 of these engines, relied upon them entirely for primary power. The following tabular statement shows the states in which these stations are located:

Internal-combustion oil engines—Number and horsepower, by states: 1907.

STATE.	Number of stations.	ENGINES.	
		Number.	Horsepower.
Total	18	33	6,185
Connecticut	2	4	600
Illinois	1	2	240
Louisiana	1	1	170
Massachusetts	2	3	570
New Hampshire	2	3	550
New Jersey	1	1	270
New York	1	1	170
Ohio	2	4	900
Pennsylvania	1	2	190
Rhode Island	1	4	1,000
Texas	3	7	1,450
Wisconsin	1	1	75

Water power.—The ease with which electric current may be transmitted long distances and the economy connected with its generation by the use of water power have not only greatly increased the amount of this kind of power in 1907 as compared with 1902, but indicate its continued development. The statistics represent only the central stations that were in actual operation during the respective census years. The construction of hydro-electric plants is proceeding rapidly; a number were under construction during 1907 but had not commenced operations before the close of the year; and the Bureau of the Census was advised also that extensive water-power plants were contemplated in various sections of the country. The exhaustion of the fuel supply will further stimulate the erection of these plants, but naturally their increase will be slowest in the states where fuel is most abundant.

The horsepower of the water wheels in the central stations during 1907 was more than three times as great as it was in 1902. Although the actual increase was less than that for steam power, its proportion of the total primary power, excluding auxiliary engines, increased from 24 to 33.5 per cent, while the proportion for steam power shows a nearly corresponding decrease, from 75.4 per cent in 1902 to 65.2 per cent in 1907. The greatest increase occurred in the commercial stations, which contained 97.4 per cent of the water power in 1902 and 97.8 per cent in 1907.

As with steam power, the increase in water power is due primarily to the installation of large units of 2,000 horsepower and over. The increase in the capacity of these machines represented 61.9 per cent of the total increase in water power. In other words, the large water wheels furnished about three-fifths and the small wheels two-fifths of the increase.

Digitized by Google

TABLE 29.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER AND HORSEPOWER OF WATER WHEELS, BY HORSEPOWER CAPACITY: 1907 AND 1902.

CLASS OF ENGINES.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Total:									
Number	2,481	1,390	2,328	1,308	153	82	78.5	78.0	86.3
Horsepower	1,349,087	438,472	1,318,740	427,254	30,347	11,218	207.7	208.7	170.5
500 horsepower and under:									
Number	1,910	1,192	1,761	1,112	149	80	60.2	58.4	86.2
Horsepower	320,636	174,559	296,689	164,981	23,947	9,578	83.7	79.8	150.0
Over 500 but under 1,000 horsepower:									
Number	244	85	243	84	1	1	187.1	189.3	.....
Horsepower	161,051	57,160	160,251	56,520	800	640	181.8	183.5	25.0
1,000 but under 2,000 horsepower:									
Number	161	81	160	80	1	1	98.8	100.0	.....
Horsepower	196,620	99,453	195,420	98,453	1,200	1,000	97.7	98.5	20.0
2,000 but under 5,000 horsepower:									
Number	111	32	109	32	2	.....	246.9	240.6	.....
Horsepower	330,980	107,300	326,580	107,300	4,400	.....	208.5	204.4	.....
5,000 horsepower and over:									
Number	55	(1)	55	(1)	.....	.....	.....	.....	.....
Horsepower	339,800	(1)	339,800	(1)	.....	.....	.....	.....	.....

[1] Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

The municipal stations contained only 3 of the water wheels with 1,000 horsepower and over in 1907 and but 1 in 1902. This small number of large wheels is, however, natural, as municipal plants are generally constructed for the purpose of supplying current to a single community and often for a specific purpose, and the equipment is limited to the probable needs of that community or purpose. Commercial plants, on the other hand, are constructed upon a broader, larger plan and are therefore more frequently designed to furnish current to any place to which it can be delivered at a profit.

TABLE 30.—*Commercial and municipal central electric stations—Per cent distribution, by number and horsepower capacity of water wheels: 1907 and 1902.*

CLASS OF WATER WHEELS.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total:						
Number	100.0	100.0	100.0	100.0	100.0	100.0
Horsepower	100.0	100.0	100.0	100.0	100.0	100.0
500 horsepower and under:						
Number	77.0	85.8	75.6	85.0	97.4	97.6
Horsepower	23.8	39.8	22.5	38.6	78.9	85.4
Over 500 but under 1,000 horsepower:						
Number	9.8	6.1	10.4	6.4	0.7	1.2
Horsepower	11.9	13.0	12.2	13.2	2.6	5.7
1,000 but under 2,000 horsepower:						
Number	6.5	5.8	6.9	6.1	0.7	1.2
Horsepower	14.6	22.7	14.8	23.0	4.0	8.9
2,000 but under 5,000 horsepower:						
Number	4.5	2.3	4.7	2.4	1.3	.....
Horsepower	24.5	24.5	24.8	25.1	14.5	.....
5,000 horsepower and over:						
Number	2.2	(1)	2.4	(1)	.....	.....
Horsepower	25.2	(1)	25.8	(1)	.....	.....

[1] Included in "2,000 but under 5,000 horsepower." The class "5,000 horsepower and over" not called for at the census of 1902.

With the exception of Kentucky and North Dakota, in which states very little water power is utilized in electric plants, every state that reported water power in 1902 showed an increased use of such power in 1907. Alabama, Arizona, and Delaware had no central stations operated by water power in 1902, but each contained stations so equipped in 1907. Some of the most marked gains in water power occurred in the following states: New York, from 128,785 horsepower in 1902 to 305,950 in 1907; California, from 78,933 to 208,444; Oregon, 11,195 to 102,052; Michigan, 16,085 to 85,738; Minnesota, 6,040 to 71,656; South Carolina, 10,415 to 75,430; Washington, 17,238 to 56,118; Montana, 24,000 to 56,987; and Georgia, 6,121 to 36,335. The water power reported by these 9 states represented 68.1 per cent of the total of this kind of primary power for all central stations in the United States in 1902 and 74 per cent in 1907. No water power was reported by the central stations in Florida, Louisiana, Mississippi, Oklahoma, or the District of Columbia.

For the purpose of comparing the average horsepower both of the stations as equipped with the various kinds of primary power and of the different classes of machines reported in 1907 and in 1902 the following table is given:

TABLE 31.—*Commercial and municipal central electric stations—Average horsepower, per station and per machine, of primary power: 1907 and 1902.*

KIND OF POWER.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total power:						
Per station	869	510	1,091	601	257	196
Per machine	373	235	421	253	159	134
Steam engines and steam turbines:						
Per station	675	445	844	523	254	198
Per machine	365	233	427	253	165	139
Steam engines:						
Per station	689	445	593	523	240	198
Per machine	265	233	301	253	157	139
Steam turbines:						
Per station	4,371	(1)	4,694	(1)	1,140	(1)
Per machine	2,168	(1)	2,293	(1)	668	(1)
Gas engines:						
Per station	190	121	209	131	109	64
Per machine	121	74	129	76	78	53
Water wheels:						
Per station	1,483	756	1,606	806	341	224
Per machine	544	315	566	327	198	127
Auxiliary engines:						
Per station	201	72	228	78	33	32
Per machine	78	40	83	41	21	23

[1] In 1902 steam turbines were included with steam engines.

Digitized by Google

Except for the comparatively unimportant auxiliary engines reported by municipal stations, in which there was a small decrease in horsepower per machine, there was in every instance a pronounced increase per station and per machine for the total, for all machines, and for each class of machine reported at both censuses. The smallest increase in total average capacity is shown for steam engines which, when compared with the large average power of the steam turbines, indicates that when great units of steam power have been required the steam turbine has been utilized. It is apparent, however, that since the figures for steam turbines were combined with those for steam engines in 1902 a correct understanding of the relative averages can be obtained only by the addition of the two sets of figures for 1907. The averages thus secured, for the totals of this combination, show that the increase in steam power has been on a par with that of the other kinds of primary power.

As might be expected, every class of machine reported by the commercial stations not only averaged much larger than those of the municipal stations but the increase in capacity also was greater.

The averages contained in Table 31 are based upon the horsepower as shown in Table 21, while the number of stations reporting the various kinds of power is shown in the following statement:

Commercial and municipal central electric stations—Distribution by number of stations, and kinds of primary power: 1907 and 1902.

KIND OF POWER.	Census.	Total.	Commercial.	Municipal.
Steam engines	1907	3,704	2,606	1,098
	1902	3,100	2,356	744
Steam turbines	1907	187	170	17
	1902	(1)	(1)	(1)
Gas engines	1907	294	238	56
	1902	101	86	15
Water wheels	1907	910	821	89
	1902	580	530	50
Auxiliary engines	1907	328	282	46
	1902	201	175	26

[1] In 1902 steam turbines were included with steam engines.

A total of the number of stations in this statement would be in excess of the actual number reported, since a station having several kinds of power would be repeated under each class of power with which it was equipped.

Dynamos, central stations, and electric railways.—The electric-generating machines in the central stations and electric-railway plants represent the majority of those in use in the United States, and in order to show statistics for the aggregate the totals for the two branches of the industry are combined in Table 32.

TABLE 32.—CENTRAL ELECTRIC STATIONS AND ELECTRIC RAILWAYS—NUMBER AND KILOWATT CAPACITY OF DYNAMOS IN GENERATING STATIONS, BY KIND OF DYNAMO: 1907 AND 1902.

KIND OF DYNAMO.	TOTAL.		CENTRAL STATIONS.		ELECTRIC RAILWAYS.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Central stations.	Electric railways.
Total:									
Number	15,297	15,786	12,173	12,484	3,124	3,302	[1]3.1	[1]2.5	[1]5.4
Kilowatt capacity	4,432,641	2,110,597	2,709,225	1,212,235	1,723,416	898,362	110.0	123.5	91.8
Direct-current, constant-voltage:									
Number	5,872	6,684	3,680	3,823	2,192	2,861	[1]12.1	[1]3.7	[1]23.4
Kilowatt capacity	1,347,962	1,055,411	406,460	330,065	941,502	725,346	27.7	23.1	29.8
Direct-current, constant-amperage:									
Number	1,685	3,539	1,685	3,539	(2)	(2)	[1]52.4	[1]52.4	(2)
Kilowatt capacity	80,992	145,866	80,992	145,866	(2)	(2)	[1]44.5	[1]44.5	(2)
Alternating single-phase and polyphase current:									
Number	7,740	5,563	6,808	5,122	932	441	39.1	32.9	111.3
Kilowatt capacity	3,003,687	909,320	2,221,773	736,304	781,914	173,016	230.3	201.7	351.9

[1] Decrease.

[2] Not reported.

With the exception of the dynamos in the isolated electric plants and telephone and telegraph offices, which are comparatively unimportant, the equipment covered by this table may be accepted as representing all dynamos used for the generation of electricity for general commercial and municipal use.

The total dynamo capacity as reported for the combined industry increased 2,322,044 kilowatts, or 110 per cent, of which increase the central stations contributed 1,496,990 kilowatts, or 64.5 per cent, and the electric-railway plants 825,054 kilowatts, or 35.5 per cent. It is suggestive of the intimate relation existing between the electric generators and the primary power, the force necessary to operate the dynamos, that the percentage of increase of the primary power, 106.5 per cent, should so closely approximate that of the dynamos, which was 110 per cent. The evenness of these gains is somewhat remarkable, because both for primary power and for the generators the totals represent the equipment, all of which is not necessary for present requirements. That is, the primary power no doubt represents a larger horsepower than was actually required for electrical purposes at the time of the census, as in many instances plants were equipped to furnish power in connection with other industries conducted by the companies report-

Digitized by Google

ing, as well as with a view to future demands, emergency uses, etc. Similarly the total installation of dynamos represents not only the dynamos required to generate the current actually used, but includes those held in reserve to furnish additional current when needed and to provide for breakdowns or repairs.

Of the total number of dynamos reported, the proportion in central stations was practically the same at the two censuses, i. e., 79.6 per cent in 1907 and 79.1 per cent in 1902. The proportion of kilowatt capacity of the dynamos in the central stations increased, however, from 57.4 per cent in 1902 to 61.1 per cent in 1907.

The direct-current, constant-voltage dynamos showed a total increase in capacity of 292,551 kilowatts, or 27.7 per cent, the greater part of which increase, 216,156 kilowatts, or 73.9 per cent, was for electric railways, while but 76,395, or 26.1 per cent, was contributed by the central stations. Of the total kilowatt capacity of these machines, the electric-railway plants reported nearly seven-tenths in 1907 and a proportion but slightly smaller in 1902.

The direct-current, constant-amperage machine was not reported by the electric-railway plants, as it is not adapted to that service, and the uses of the machine are so restricted that comparatively few companies doing a general light and power business feel justified in carrying a class of dynamo only fitted for series arc lighting. The number of this class of dynamos reported by the central stations in 1907 was less than one-half the number so reported in 1902, and the decrease in their total capacity amounted to 64,874 kilowatts, or 44.5 per cent.

The alternating single-phase and polyphase current dynamo showed the largest actual and percentage of gain, due to the fact that it is adapted to almost every use required of a dynamo. The total capacity of these machines increased 2,094,367 kilowatts, or 230.3 per cent. Of this gain, 1,485,469 kilowatts, or 70.9 per cent, was represented by the central stations. Electric-railway plants reported a little more than one-fourth of the total capacity of these dynamos in 1907 and not quite one-fifth in 1902.

Table 33 shows the per cent distribution, by kind, of the dynamos in the central stations and electric-railway plants for 1902 and 1907.

Notwithstanding the increase of 27.7 per cent in the total capacity of the direct-current, constant-voltage dynamos in 1907, they represented only about three-tenths of the total capacity of all classes of dynamos in that year as compared with one-half of the total in 1902. The capacity of the alternating-current dynamos, which in 1902 represented but little more than four-tenths of the total for all classes, had increased its proportion to more than two-thirds in 1907. The direct-current, constant-amperage dynamos, as already stated, were all reported by the central stations, and the small proportion which they supplied of the total kilowatt capacity decreased from nearly 7 per cent in 1902 to slightly less than 2 per cent in 1907.

TABLE 33.—*Central electric stations and electric railways—Per cent distribution, by kind and by number and capacity of dynamos: 1907 and 1902.*

KIND OF DYNAMO.	TOTAL.		CENTRAL STATIONS.		ELECTRIC RAILWAYS.	
	1907	1902	1907	1902	1907	1902
Total:						
Number	100.0	100.0	100.0	100.0	100.0	100.0
Kilowatt capacity	100.0	100.0	100.0	100.0	100.0	100.0
Direct-current, constant-voltage:						
Number	38.4	42.3	30.2	30.6	70.2	86.6
Kilowatt capacity	30.4	50.0	15.0	27.2	54.6	80.7
Direct-current, constant-amperage:						
Number	11.0	22.4	13.8	28.3	(1)	(1)
Kilowatt capacity	1.8	6.9	3.0	12.0	(1)	(1)
Alternating single-phase and polyphase current:						
Number	50.6	35.2	55.9	41.0	29.8	13.4
Kilowatt capacity	67.8	43.1	82.0	60.7	45.4	19.3

[1] Not reported by electric railways.

Dynamos in central stations.—As compared with the total kilowatt capacity of all dynamos reported in 1902 there was an increase in 1907 of 1,496,990 kilowatts, or 123.5 per cent. Of this increase, the commercial stations reported 1,401,354 kilowatts, or 93.6 per cent, and the municipal stations only 95,636 kilowatts, or 6.4 per cent. In 1907 the commercial stations reported 92.3 per cent of the total dynamo capacity and the municipal stations 7.7 per cent. When compared with similar proportions for the prior census it is found that the percentage for the commercial stations was 1.7 per cent greater than in 1902.

The increase in the number and in the capacity of the dynamos of the different kinds in commercial and municipal stations is shown by the figures in Table 34, while Table 35 gives the per cent distribution of such dynamos, by kind, for 1907 and 1902.

The advantages possessed by the alternating-current dynamo and its adaptability for general central-station work is illustrated by the tremendous gain in its use. Practically the entire increase in dynamo capacity was due to the gain made by the alternating-current machine, as the direct-current, constant-amperage machines lost 64,874 in kilowatt capacity, which was but little more than counterbalanced by a gain of 76,395 kilowatts in the capacity of the direct-current, constant-voltage machines.

Digitized by Google

TABLE 34.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER AND KILOWATT CAPACITY OF DYNAMOS IN GENERATING STATIONS, BY KIND OF DYNAMO: 1907 AND 1902.

KIND OF DYNAMO.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Total:									
Number	12,173	12,484	9,778	10,662	2,395	1,822	[1]2.5	[1]8.3	31.4
Kilowatt capacity	2,709,225	1,212,235	2,500,209	1,098,855	209,016	113,380	123.5	127.5	84.3
Direct-current, constant-voltage:									
Number	3,680	3,823	3,169	3,405	511	418	[1]3.7	[1]6.9	22.2
Kilowatt capacity	406,460	330,065	379,706	312,509	26,754	17,556	23.1	21.5	52.4
Direct-current, constant-amperage:									
Number	1,685	3,539	1,246	2,957	439	582	[1]52.4	[1]57.9	[1]24.6
Kilowatt capacity	80,992	145,866	61,753	117,695	19,239	28,171	[1]44.5	[1]47.5	[1]31.7
Alternating single-phase and polyphase current:									
Number	6,808	5,122	5,363	4,300	1,445	822	32.9	24.7	75.8
Kilowatt capacity	2,221,773	736,304	2,058,750	668,651	163,023	67,653	201.7	207.9	141.0

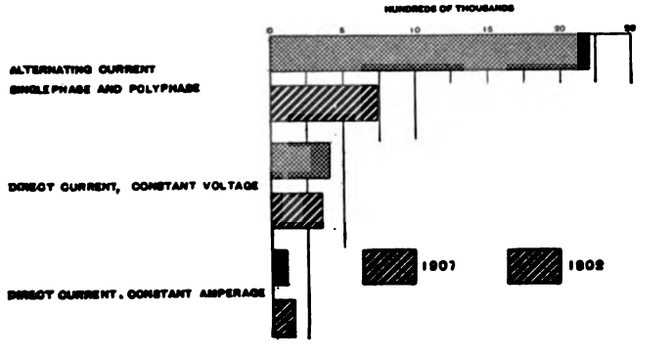
[1] Decrease.

Although the kilowatt capacity of the direct-current, constant-voltage dynamos had increased nearly one-fourth since 1902, the relative importance of these machines was considerably less in 1907. The number and capacity of the direct-current, constant-amperage dynamos has decreased since 1902, as has their relative importance.

TABLE 35.—*Commercial and municipal central electric stations—Per cent distribution, by kind and by number and capacity of dynamos: 1907 and 1902.*

KIND OF DYNAMO.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total:						
Number	100.0	100.0	100.0	100.0	100.0	100.0
Kilowatt capacity	100.0	100.0	100.0	100.0	100.0	100.0
Direct-current, constant-voltage:						
Number	30.2	30.6	32.4	31.9	21.3	22.9
Kilowatt capacity	15.0	27.2	15.2	28.4	12.8	15.5
Direct-current, constant-amperage:						
Number	13.8	28.3	12.7	27.7	18.3	31.9
Kilowatt capacity	3.0	12.0	2.5	10.7	9.2	24.8
Alternating single-phase and polyphase current:						
Number	55.9	41.0	54.8	40.3	60.3	45.1
Kilowatt capacity	82.0	60.7	82.3	60.8	78.0	59.7

DIAGRAM 5.—*Central electric stations—Capacity of dynamos: 1907 and 1902.*



The average capacity of the different types of dynamos per station and per machine for commercial and municipal stations, 1907 and 1902, is shown in Table 36.

TABLE 36.—*Commercial and municipal central electric stations—Average kilowatt capacity of dynamos, by kind, per station, and per machine: 1907 and 1902.*

KIND OF DYNAMO.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total kilowatt capacity:						
Per station	575	335	722	392	167	139
Per machine	223	97	256	103	87	62
Direct-current, constant-voltage:						
Per station	256	228	298	262	85	70
Per machine	110	86	120	92	52	42
Direct-current, constant-amperage:						
Per station	149	126	181	136	96	95
Per machine	48	41	50	40	44	48
Alternating single-phase and polyphase current:						
Per station	645	280	816	323	177	120
Per machine	326	144	384	156	113	82

The average capacity of the several classes of dynamos, per station and per machine, was determined from the number of these machines as shown in Table 34, and the number of stations reporting the different types of dynamos is shown in the following statement:

Commercial and municipal central electric stations—Number of stations, by kind of dynamo: 1907 and 1902.

KIND OF DYNAMO.	Census.	Total.	Commercial.	Municipal.
Direct-current, constant-voltage	1907	1,588	1,273	315
	1902	1,447	1,195	252
Direct-current, constant-amperage	1907	542	342	200
	1902	1,160	864	296
Alternating single-phase and polyphase current.	1907	3,446	2,524	922
	1902	2,634	2,069	565

The increase in the total average capacity of the dynamos per station and per machine, shown in Table 36, is in keeping with the general tendency toward larger units of equipment in almost all branches of central-station work.

For the direct-current dynamos there was an increase, although not very pronounced, both per station and per machine. The constant-amperage dynamos in the municipal stations form the single exception to an increase, the average capacity of these dynamos showing a decrease per machine from 48 to 44 kilo-

Digitized by Google

watts. There has been a large decrease in the number of this latter class of dynamos and probably but few new ones installed, and the figures indicate that those removed have been the machines of the larger capacity. In harmony with the great increase in the kilowatt capacity shown for the alternating-current dynamo in other tables, the table of average capacity shows an increase in every detail presented.

A better understanding of the dynamo equipment of central stations may be obtained from a study of the detailed statistics showing the number and capacity of the different types of machines, grouped according to size. The totals for the United States are summarized in Table 37.

TABLE 37.—*Central electric stations—Kind of dynamos, by class, number, and kilowatt capacity: 1907.*

CLASS OF DYNAMO.	Total.	Direct-current, constant-voltage.	Direct-current, constant-amperage.	Alternating single-phase and polyphase current.
Total:				
Number	12,173	3,680	1,685	6,808
Kilowatt capacity	2,709,225	406,460	80,992	2,221,773
Under 200 kilowatt capacity:				
Number	9,491	3,128	1,664	4,699
Kilowatt capacity	664,440	183,865	71,649	408,926
Per cent of total kilowatt capacity	24.5	45.2	88.5	18.4
200 but under 500 kilowatt capacity:				
Number	1,547	417	16	1,114
Kilowatt capacity	434,586	115,155	4,833	314,598
Per cent of total kilowatt capacity	16.0	28.3	6.0	14.2
500 but under 1,000 kilowatt capacity:				
Number	624	102	3	519
Kilowatt capacity	390,149	63,890	2,010	324,249
Per cent of total kilowatt capacity	14.4	15.7	2.5	14.6
1,000 but under 2,000 kilowatt capacity:				
Number	281	30	2	249
Kilowatt capacity	351,700	36,550	2,500	312,650
Per cent of total kilowatt capacity	13.0	9.0	3.1	14.1
2,000 but under 5,000 kilowatt capacity:				
Number	163	3	.....	160
Kilowatt capacity	438,350	7,000	.....	431,350
Per cent of total kilowatt capacity	16.2	1.7	.....	19.4
5,000 kilowatt capacity and over:				
Number	67	.....	.....	67
Kilowatt capacity	430,000	.....	.....	430,000
Per cent of total kilowatt capacity	15.9	.....	.....	19.4

Of the direct-current, constant-voltage dynamo capacity, 73.5 per cent was represented by the machines of less than 500 kilowatts; 24.7 per cent by those in the two classes 500 but under 2,000 kilowatt capacity; only 1.7 per cent by those in the class "2,000 but under 5,000 kilowatt capacity;" and none in the class "5,000 kilowatt capacity and over."

The direct-current, constant-amperage machines show even a larger proportion in the small classes, the class of "under 200 kilowatt capacity" having 88.5 per cent, with small proportions in the next three classes and no dynamo of this type of 2,000 kilowatt capacity or over.

The remarkable increase in the use of the alternating-current dynamo has already been shown, and its adaptability to the varying requirements as to capacity are demonstrated by the evenness of its distribution among the several classes, the variation in the proportion of the six classes ranging from only 14.1 per cent for the class of the lowest total capacity to 19.4 for the class of the highest. Beginning with the class with the smallest kilowatt capacity, the proportions of the total capacity for all kinds of dynamos contributed by the alternating-current were as follows: 61.5; 72.4; 83.1; 88.9; 98.4; and 100 per cent, the proportion thus steadily increasing with the capacity of the dynamo.

In Table 38 the dynamos in commercial and municipal stations, respectively, have been grouped according to the capacity of the separate machines.

TABLE 38.—*Commercial and municipal central electric stations—Dynamos, by number and kilowatt capacity: 1907.*

CLASS OF DYNAMO.	Total.	Commercial.	Municipal.
Total:			
Number	12,173	9,778	2,395
Kilowatt capacity	2,709,225	2,500,209	209,016
Under 200 kilowatt capacity:			
Number	9,491	7,283	2,208
Kilowatt capacity	664,440	513,427	151,013
200 but under 500 kilowatt capacity:			
Number	1,547	1,375	172
Kilowatt capacity	434,586	389,833	44,753
500 but under 1,000 kilowatt capacity:			
Number	624	613	11
Kilowatt capacity	390,149	383,699	6,450
1,000 but under 2,000 kilowatt capacity:			
Number	281	278	3
Kilowatt capacity	351,700	346,900	4,800
2,000 but under 5,000 kilowatt capacity:			
Number	163	162	1
Kilowatt capacity	438,350	436,350	2,000
5,000 kilowatt capacity and over:			
Number	67	67	.....
Kilowatt capacity	430,000	430,000	.....

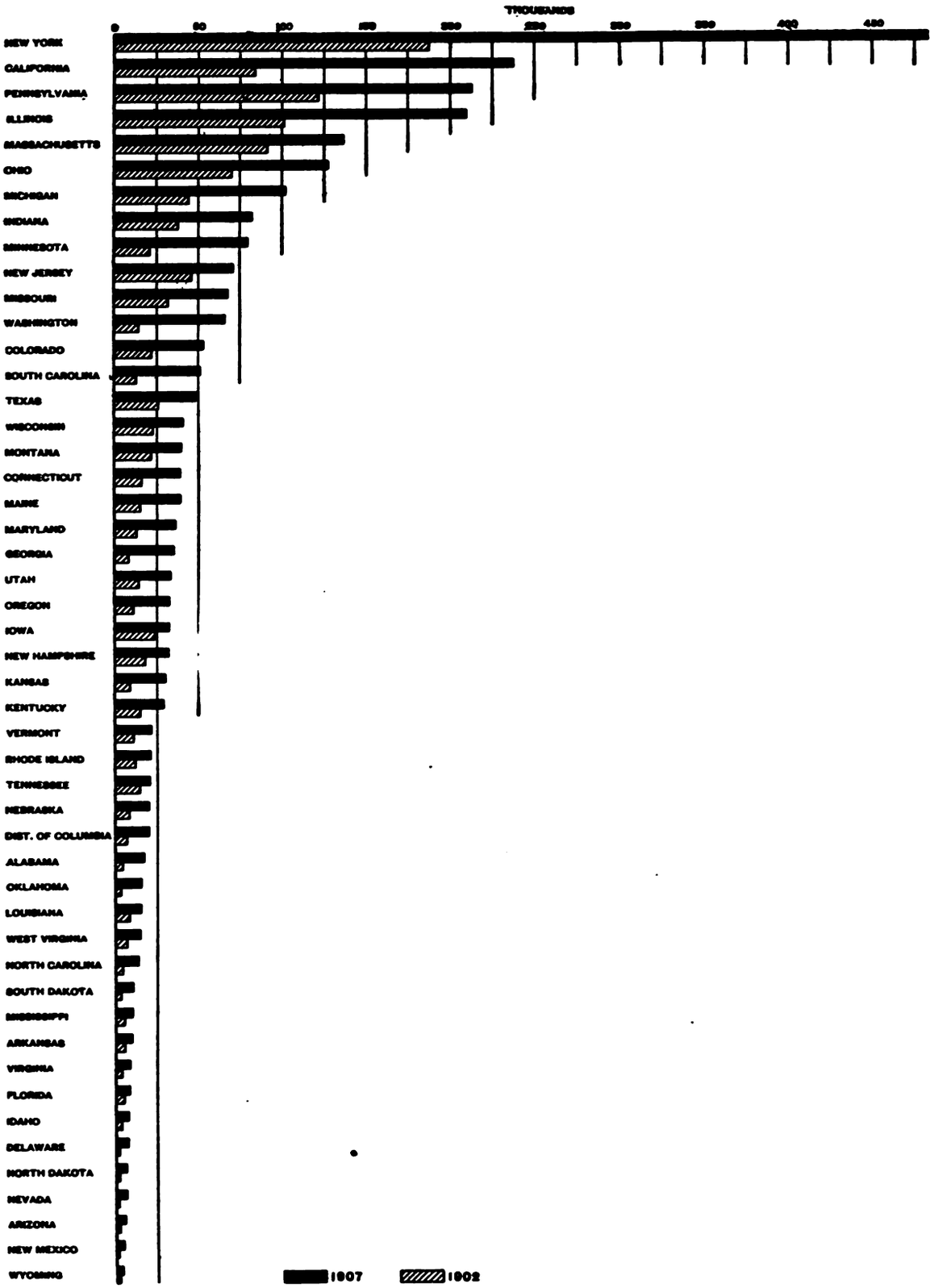
This table shows in every class not only the great preponderance of the dynamo capacity of commercial over municipal stations, but also the little use of dynamos of large capacity in the municipal stations.

The increase in dynamo capacity is practically confined to the states for which statistics are given in Table 39.

The total increase in the dynamo capacity of these 21 states, each of which made a gain of over 20,000 kilowatts, amounted to 1,256,929 kilowatts, or 84 per cent of the total increase for the entire United States. To illustrate the extent to which single-phase and polyphase dynamos have superseded the other varieties of machines, the increase in their kilowatt capacity is shown separately and is found to approximate closely the total increase for all machines, the difference for the selected states being but 2,361 kilowatts, or less than two-tenths of 1 per cent, and that for the entire United States 11,521 kilowatts, or about eight-tenths of 1 per cent. In some states the increase in the capacity of the alternating-current machines exceeds that for all classes of dynamos; due to the fact that there was an actual decrease in the capacity of the direct-current machines in several states.

Digitized by Google

DIAGRAM 6.—CENTRAL ELECTRIC STATIONS—CAPACITY OF DYNAMOS, BY STATES, ARRANGED IN THE ORDER OF THEIR RELATIVE IMPORTANCE: 1907 AND 1902.



Digitized by Google

In each of 8 states—California, Illinois, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Washington—the increase in the capacity of dynamos exceeded 50,000 kilowatts. The total increase in these states amounted to 873,910, or 58.4 per cent of the total gain for the United States. In 3 states—California, Illinois, and New York—the dynamo capacity increased more than 100,000 kilowatts each, the total amounting to 558,349 kilowatts, or 37.3 per cent of the total gain for all stations.

TABLE 39.—CENTRAL ELECTRIC STATIONS—KILOWATT CAPACITY OF DYNAMOS IN THE STATES WHICH INCREASED THEIR CAPACITY OVER 20,000 KILOWATTS: 1907 AND 1902.

STATE.	KILOWATT CAPACITY.					
	Total.		Actual increase.	Per cent of increase.	Per cent distribution of increase.	Actual increase in capacity of alternating single-phase and polyphase current dynamos.
	1907	1902				
Total for United States	2,709,225	1,212,235	1,496,990	123.5	100.0	1,485,469
Total for selected states	2,238,059	981,130	1,256,929	128.1	84.0	1,254,568
California	238,480	83,816	154,664	184.5	10.3	161,830
Colorado	53,130	21,808	31,322	143.6	2.1	32,423
Connecticut	39,363	15,516	23,847	153.7	1.6	21,221
Georgia	35,446	7,620	27,826	365.2	1.9	27,595
Illinois	209,226	100,320	108,906	108.6	7.3	115,873
Indiana	81,576	38,144	43,432	113.9	2.9	41,104
Kansas	30,307	8,596	21,711	252.6	1.5	18,320
Maine	39,290	15,291	23,999	156.9	1.6	22,158
Maryland	36,223	13,207	23,016	174.3	1.5	24,105
Massachusetts	135,924	90,624	45,300	50.0	3.0	53,993
Michigan	101,714	44,176	57,538	130.2	3.8	60,492
Minnesota	78,516	20,999	57,517	273.9	3.8	52,496
Missouri	68,467	32,100	36,367	113.3	2.4	39,318
New Jersey	70,566	46,120	24,446	53.0	1.6	20,316
New York	482,031	187,252	294,779	157.4	19.7	295,359
Ohio	126,533	69,811	56,722	81.3	3.8	58,050
Oregon	32,587	11,165	21,422	191.9	1.4	19,325
Pennsylvania	212,543	121,388	91,155	75.1	6.1	82,198
South Carolina	51,271	13,390	37,881	282.9	2.5	38,370
Texas	48,558	26,108	22,450	86.0	1.5	17,858
Washington	66,308	13,679	52,629	384.7	3.5	52,164
All other states	471,166	231,105	240,061	103.9	16.0	230,901

In addition to the dynamos, the number and capacity of the auxiliary machines used in connection with the distribution of the electric energy were reported, and the statistics for them are summarized in Table 40.

TABLE 40.—*Commercial and municipal central electric stations—Number and kilowatt capacity of miscellaneous main-station equipment: 1907 and 1902*

KIND OF EQUIPMENT.	Census.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
		Number.	Kilowatt capacity.	Number.	Kilowatt capacity.	Number.	Kilowatt capacity.
Transformers[1]	1907	1,577	592,708	1,432	587,421	145	5,287
Rotaries	1907	180	52,416	175	51,703	5	713
	1902	132	47,608	131	47,508	1	100
Boosters	1907	127	4,810	106	4,474	21	336
	1902	193	13,361	184	13,230	9	131
Storage-battery cells	1907	9,751	.....	9,255	.....	496	.....
	1902	6,881	.....	5,981	.....	900	.....
Miscellaneous[2]	1907	.....	43,209	.....	42,256	.....	953

[1] Not reported as main-station equipment in 1902.
[2] Includes motor generators, motors, regulators, and other accessories. Not reported as main-station equipment in 1902.

The transformers in the main station, which are chiefly those used to raise the voltage generated for purposes of transmission, and miscellaneous machines were not called for in 1902 as connected with the generating plant; hence the extent of their use at that census can not be determined. The transformers probably were reliably reported, but it was apparent from an examination of the reports that there was little uniformity among the electric companies in reporting their miscellaneous machines. The commercial stations, which reported most of the boosters, show a decided decrease in these machines in 1907, which is in harmony with the later dynamo equipment and more recent methods followed in central-station management.

The substation equipment, as reported at the two censuses, is shown in Table 41.

TABLE 41.—*Commercial and municipal central electric stations—Number and kilowatt capacity of substation equipment, by kind: 1907 and 1902.*

KIND OF EQUIPMENT.	Census.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
		Number.	Kilowatt capacity.	Number.	Kilowatt capacity.	Number.	Kilowatt capacity.
Transformers	1907	4,211	1,100,824	4,047	1,090,261	164	10,563
	1902	1,800	312,848	1,765	311,879	35	969
Rotaries	1907	490	311,003	490	311,003	.....	.....
	1902	169	81,728	168	81,721	1	7
Storage-battery cells	1907	20,187	.....	20,187	.....	.....	.....
	1902	8,388	.....	8,388	.....	.....	.....
Miscellaneous[1]	1907	.....	99,275	.....	98,117	.....	1,158
	1902	.....	15,997	.....	15,867	.....	130

[1] Includes motor generators, motors, regulators, and other accessories.

Digitized by Google

It is evident that the electric service performed by the municipal stations was of a character which necessitated a very limited use of substations. Of the 1,093 substations reported for all central stations, only 57 were connected with municipal stations, and practically their entire equipment was confined to a few step-down transformers.

OUTPUT OF STATIONS.

The product of central electric stations is electrical energy or current and the operations of such stations are measured by this output in kilowatt hours. Accordingly, as in 1902, an inquiry with respect to the total output of current for the year in kilowatt hours was made a part of the schedule. With many establishments, the output is a matter of scientific accounting, being carefully recorded from the actual watt-hour or kilowatt-hour readings of dynamo meters. Many other establishments, however, particularly the smaller plants, could give no exact data in reply to this inquiry, but were asked to make careful estimates. There is thus a considerable element of estimate in the figures, but it is believed that it is not sufficiently large to vitiate or to impair seriously their statistical value.

TABLE 42.—*Central electric stations and electric railways—Output of generating stations: 1907 and 1902.*

	KILOWATT HOURS.		Per cent of increase.
	1907	1902	
Total	10,621,406,837	4,768,535,512	122.7
Central stations	5,862,276,737	2,507,051,115	133.8
Electric railways	4,759,130,100	2,261,484,397	110.4

There were 10,621,406,837 kilowatt hours of current generated in central stations and electric-railway plants in 1907 compared with 4,768,535,512 in 1902, an increase of 122.7 per cent. Central stations reported 55.2 per cent of the total output in 1907 as compared with 52.6 per cent in 1902.

It is interesting to compare the total kilowatt capacity of dynamos with the annual output of current. Confining this comparison to central stations, the total kilowatt-hour capacity of such stations in 1907 was reported as 2,709,225, and the annual output was 5,862,276,737 kilowatt hours. Assuming that the stations could be operated continuously twenty-four hours a day for 365 days, or one year, at their maximum capacity, the theoretical annual capacity would be 23,732,811,000 kilowatt hours; the actual output, however, was only 24.7 per cent, or less than one-fourth, of this amount. The corresponding percentage at the census of 1902 was 23.6. As illustrating the same point, a division of the kilowatt capacity of the dynamos into the output for the year gives, theoretically, the number of hours of operation of the generators on the basis of their maximum capacity. The figures, thus derived, 2,164 for 1907 and 2,068 for 1902, when compared with the total number of hours in a year of 365 days, 8,760, show in another way the difference between the theoretical maximum capacity and the actual conditions as reported. There are, however, several circumstances which lessen the value of such comparisons. The indicated capacity of a dynamo is the theoretical maximum capacity or greatest load at which it can be operated. It is mechanically impossible, of course, to operate dynamos or other machinery at maximum capacity for any length of time, and the necessity for repairs frequently puts the generating machinery wholly out of commission. Many central stations, especially those of large capacity, have installed duplicate machines to provide against accident, and thus throughout the year a considerable part of their equipment is idle. Again, to render satisfactory service to the consumers, a station should be equipped to transmit sufficient current to satisfy the largest possible demand. Therefore as the consumption varies from the peak of the load capacity to a small fraction of it the speed of the dynamos is moderated, or some of them are stopped altogether, in accordance with the requirements. A large proportion of the smaller plants operate only during the hours of darkness, and many during the few hours from sunset to midnight. These and other factors, therefore, combine to explain the difference, previously noted, between the actual output of the central-station dynamos and the output which they are theoretically capable of generating.

The income received during the year 1907 by central stations from the sale of current amounted to $169,614,691; the total output of stations was 5,862,276,737 kilowatt hours; the average earnings per kilowatt hour therefore appear to have been about $2\frac{9}{10}$ cents, compared with $3\frac{4}{10}$ cents in 1902. Improved methods of transmission in 1907 over 1902, resulting in a decreased loss of current, the large increase in the average capacity of the generating units, and economies in other directions, have no doubt reduced the cost of production and thus make possible the delivery of current at a lower figure.

A comparison of the output of commercial and municipal stations reveals the comparative unimportance of the latter in that respect.

TABLE 43.—*Commercial and municipal central electric stations—Output of generating stations: 1907 and 1902.*

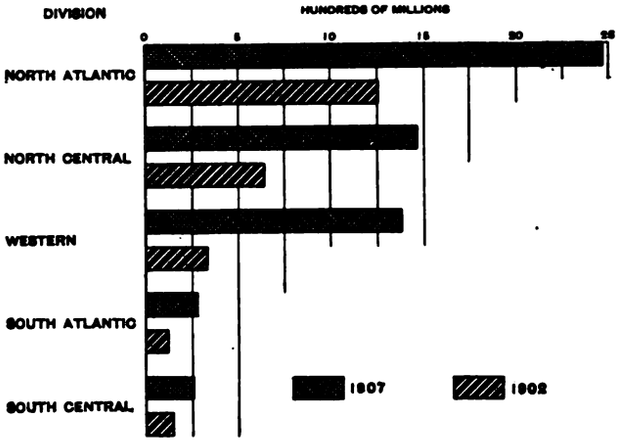
	KILOWATT HOURS.		Per cent of increase.
	1907	1902	
Total	5,862,276,737	2,507,051,115	133.8
Commercial	5,572,813,949	2,311,146,676	141.1
Municipal	289,462,788	195,904,439	47.8

Digitized by Google

From 1902 to 1907 the output of municipal stations increased only 47.8 per cent, while the output of commercial stations increased 141.1 per cent. The greater importance of commercial stations is still further shown in the fact that the percentage which their output formed of the total for all central stations increased from 92.2 in 1902 to 95.1 in 1907, while as a necessary sequence the proportion of municipal stations dropped from 7.8 per cent to 4.9 per cent.

The increase in output of electric current is an accurate measure of the increase in importance of the central stations in other particulars—investment, equipment, etc. The accompanying diagram shows the output for each geographic division for 1907 and 1902.

DIAGRAM 7.—*Central electric stations—Output, by geographic divisions: 1907 and 1902.*



The following table illustrates the differences which mark the rate of development of the use of electric current for light and power in the several states. The output in every state shows an increase in 1907 over 1902. The largest actual increase is shown for New York, with California, Illinois, Washington, Pennsylvania, Michigan, and Montana following in the order named, each with an increase of more than 100,000,000 kilowatt hours. On the other hand the states which show the largest percentages of increase are Nevada, Washington, Oklahoma, Georgia, Oregon, Kansas, and California, in the order given, each with an increase exceeding 300 per cent. The smallest increase in both amount and per cent was for Iowa.

TABLE 44.—*Central electric stations—Output of generating stations, by states and territories, with per cent of increase and per cent distribution of total increase: 1907 and 1902.*

STATE OR TERRITORY.	OUTPUT OF STATIONS (KILOWATT HOURS). 1907	1902	Actual increase.	Per cent of increase.	Per cent distribution of increase.
United States...	5,862,276,737	2,507,051,115	3,355,225,622	133.8	100.0
Alabama	30,846,764	11,616,707	19,230,057	165.5	0.6
Arizona	9,392,302	3,662,045	5,730,257	156.5	0.2
Arkansas	11,519,316	9,965,997	1,553,319	15.6	(1)
California	661,606,309	152,728,042	508,878,267	333.2	15.2
Colorado	123,275,212	60,177,084	63,098,128	104.9	1.9
Connecticut	67,406,232	26,738,121	40,668,111	152.1	1.2
Delaware and District of Columbia	30,543,522	17,871,872	12,671,650	70.9	0.4
Florida	11,765,994	8,066,078	3,699,916	45.9	0.1
Georgia	59,311,202	9,911,243	49,399,959	498.4	1.5
Idaho	9,577,588	5,018,149	4,559,439	90.9	0.1
Illinois	467,657,328	161,543,646	306,113,682	189.5	9.1
Indiana	130,213,693	75,585,493	54,678,200	72.3	1.6
Iowa	37,729,072	36,506,425	1,222,647	3.3	(1)
Kansas	59,740,179	13,326,518	46,413,661	348.3	1.4
Kentucky	37,232,623	27,835,614	9,397,009	33.8	0.3
Louisiana	26,421,316	17,474,261	8,947,055	51.2	0.3
Maine	66,136,651	21,987,700	44,148,951	200.8	1.3
Maryland	47,868,675	22,128,125	25,740,550	116.3	0.8
Massachusetts	219,425,607	125,813,392	93,612,215	74.4	2.8
Michigan	208,154,199	80,564,630	127,589,569	158.4	3.8
Minnesota	87,579,431	40,258,632	47,320,799	117.5	1.4
Mississippi	15,704,624	9,825,926	5,878,698	59.8	0.2
Missouri	147,328,446	57,450,731	89,877,715	156.4	2.7
Montana	137,379,261	36,435,766	100,943,495	277.0	3.0
Nebraska	31,958,739	12,315,775	19,642,964	159.5	0.6
Nevada	29,621,730	1,508,910	28,112,820	1,863.1	0.8
New Hampshire	55,258,921	27,377,793	27,881,128	101.8	0.8
New Jersey	140,527,522	78,739,456	61,788,066	78.5	1.8
New Mexico	4,614,349	2,637,810	1,976,539	74.9	0.1
New York	1,452,222,471	701,769,716	750,452,755	106.9	22.4
North Carolina	13,171,681	8,351,346	4,820,335	57.7	0.1
North Dakota	8,229,765	5,850,115	2,379,650	40.7	0.1
Ohio	217,311,924	127,437,383	89,874,541	70.5	2.7
Oklahoma	24,985,903	3,825,763	21,160,140	553.1	0.6
Oregon	92,807,992	17,531,660	75,276,332	429.4	2.2
Pennsylvania	416,554,167	241,094,328	175,459,839	72.8	5.2
Rhode Island	35,651,323	23,436,435	12,214,888	52.1	0.4
South Carolina	68,696,424	18,426,763	50,269,661	272.8	1.5
South Dakota	13,615,015	4,256,007	9,359,008	219.9	0.3
Tennessee	34,847,956	24,472,632	10,375,324	42.4	0.3
Texas	75,829,108	48,888,450	26,940,658	55.1	0.8
Utah	61,672,661	32,457,063	29,215,598	90.0	0.9
Vermont	29,923,333	22,374,060	7,549,273	33.7	0.2
Virginia	10,208,360	6,879,243	3,329,117	48.4	0.1
Washington	257,785,236	19,722,262	238,062,974	1,207.1	7.1
West Virginia	24,871,317	11,355,905	13,515,412	119.0	0.4
Wisconsin	52,546,210	29,966,758	22,579,452	75.3	0.7
Wyoming	5,499,084	3,883,285	1,615,799	41.6	(1)

[1] Less than one-tenth of 1 per cent.

Digitized by Google

CHAPTER IV.

LINE EQUIPMENT.

Central stations and electric railways.—The prevalence of the lighting and general motor service among the electric-railway companies makes it necessary to combine their equipment with that of the central stations in order to show the total number of lamps, meters, transformers, and stationary motors wired for service. Such totals are given in Table 45.

TABLE 45.—CENTRAL-ELECTRIC STATIONS AND ELECTRIC RAILWAYS—LAMPS, METERS, TRANSFORMERS IN CIRCUITS, AND STATIONARY MOTORS: 1907 AND 1902.

	TOTAL.		CENTRAL STATIONS.		ELECTRIC RAILWAYS.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Central stations.	Electric railways.
Arc lamps	635,815	419,561	555,713	385,698	80,102	33,863	51.5	44.1	136.5
Public	318,819	229,403	289,391	211,725	29,428	17,678	39.0	36.7	66.5
Commercial	316,996	190,158	266,322	173,973	50,674	16,185	66.7	53.1	213.1
Incandescent lamps	45,991,836	19,636,729	41,445,997	18,194,044	4,545,839	1,442,685	134.2	127.8	215.1
Public	866,851	474,686	808,693	455,660	58,158	19,026	82.6	77.5	205.7
Commercial	45,124,985	19,162,043	40,637,304	17,738,384	4,487,681	1,423,659	135.5	129.1	215.2
Other varieties of lamps—Nernst, vacuum, vapor, etc.	190,979	(1)	162,338	(1)	28,641	(1)	.....	.....	.....
Public	6,090	(1)	5,716	(1)	374	(1)	.....	.....	.....
Commercial	184,889	(1)	156,622	(1)	28,267	(1)	.....	.....	.....
Lamps used by the central stations to light their own electric properties	1,107,116	(1)	275,079	(1)	832,037	(1)	.....	.....	.....
Meters on consumption circuits	1,897,803	639,290	1,683,917	582,689	213,886	56,601	196.9	189.0	277.9
Transformers in circuits for customers:									
Number	299,489	207,370	299,489	207,370	(2)	(2)	44.4	44.4	.....
Kilowatt capacity	2,058,567	687,121	2,058,567	687,121	(2)	(2)	199.6	199.6	.....
Stationary motors: [3]									
Number	187,652	111,113	167,184	101,064	20,468	10,049	68.9	65.4	103.7
Horsepower	1,807,949	473,693	1,649,026	438,005	158,923	35,688	281.7	276.5	345.3

[1] Not reported separately. [2] Not called for in schedule for electric railways. [3] Some fan motors were included in 1902, but such motors were omitted in 1907.

The apparatus represented by the statistics in this table is characteristic of central-station work, and although a considerable proportion is connected with railway plants, it all belongs to the same department of industry. For the two branches of service together an aggregate of 47,925,746 lamps is shown for 1907 as compared with 20,056,290 for 1902, the increase amounting to 27,869,456, or 139 per cent. Of the total number of lamps, the central stations reported 88.6 per cent in 1907 and 92.6 per cent in 1902, and the electric railways, 11.4 per cent in 1907 and 7.4 per cent in 1902. In 1902 the railways reported 8.1 per cent of the arc lamps and 7.3 per cent of the incandescent lamps; at the census of 1907 these proportions had increased to 12.6 and 9.9 per cent, respectively.

Large increases are shown for all of the items of equipment, and in every instance the percentage of increase was much larger for the electric-railway plants than for the central stations. Several causes contribute to this condition, among which may be mentioned the method of preparing the reports when a central station and electric-railway plant are united and keep only one system of accounts. The tendency toward such combination in the interest of economy has been very general, and when separate reports for the two branches could not be furnished, the combined industry was returned as an electric railway rather than as a central station, irrespective of the relative importance of the two branches.

The electric-railway branch of the characteristic central-station industry is, however, of very minor importance, comparatively, and the large percentages of increase in its apparatus have little effect on the increases shown for the total apparatus used in furnishing electric light and power.

CENTRAL STATIONS.

Lamps, meters, transformers, and stationary motors.—The lamps used for lighting streets, parks, public buildings, and all other public places for the illumination of which the municipality or other local government was responsible, were considered as devoted to the "public service," and were reported separately from those used in general "commercial service" in lighting residences, places of business, etc., for which individuals or private enterprises were responsible. The number of lamps for these two branches of service are shown in Table 46, which presents also data concerning the meters, transformers, and motors.

Digitized by Google

TABLE 46.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—LAMPS, METERS, TRANSFORMERS IN CIRCUITS, AND STATIONARY MOTORS: 1907 AND 1902.

	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Arc lamps	555,713	385,698	472,773	334,903	82,940	50,795	44.1	41.2	63.3
Public	289,391	211,725	216,309	166,723	73,082	45,002	36.7	29.7	62.4
Commercial	266,322	173,973	256,464	168,180	9,858	5,793	53.1	52.5	70.2
Incandescent lamps	41,445,997	18,194,044	37,393,549	16,616,593	4,052,448	1,577,451	127.8	125.0	156.9
Public	808,693	455,660	638,456	372,740	170,237	82,920	77.5	71.3	105.3
Commercial	40,637,304	17,738,384	36,755,093	16,243,853	3,882,211	1,494,531	129.1	126.3	159.8
Other varieties of lamps—Nernst, vacuum, vapor, etc.	162,338	(1)	153,468	(1)	8,870	(1)	.....	.....	.....
Public	5,716	(1)	4,584	(1)	1,132	(1)	.....	.....	.....
Commercial	156,622	(1)	148,884	(1)	7,738	(1)	.....	.....	.....
Lamps used by the central stations to light their own electric properties	275,079	(1)	245,905	(1)	29,174	(1)	.....	.....	.....
Arc	7,082	(1)	6,487	(1)	595	(1)	.....	.....	.....
Incandescent	266,242	(1)	237,729	(1)	28,513	(1)	.....	.....	.....
All other lamps	1,755	(1)	1,689	(1)	66	(1)	.....	.....	.....
Meters on consumption circuits	1,683,917	582,689	1,468,763	526,011	215,154	56,678	189.0	179.2	279.6
Transformers in circuits for customers:									
Number	299,489	207,370	255,337	179,300	44,152	28,070	44.4	42.4	57.3
Kilowatt capacity	2,058,567	687,121	1,897,170	612,442	161,397	74,679	199.6	209.8	116.1
Stationary motors:[2]									
Number	167,184	101,064	162,677	99,102	4,507	1,962	65.4	64.2	129.7
Horsepower	1,649,026	438,005	1,617,337	434,681	31,689	3,324	276.5	272.1	853.3

[1] Not reported separately.

[2] Some fan motors were included in 1902, but such motors were omitted in 1907.

Although every item of equipment specified in the table shows a large increase in 1907 as compared with 1902, the most notable increases and those indicating most nearly the progress in the industry are those for incandescent lamps, stationary motors, meters on consumption circuits, and transformers in circuits for customers. The number of incandescent lamps is necessarily, to some extent, an estimate. Accepting these estimates, there were 42,439,127 lamps of all varieties connected with the central stations at the close of 1907 and 18,579,742 at the close of 1902, the increase for the five years amounting to 23,859,385 lamps, or 128.4 per cent. While this increase in the aggregate number of lamps indicates the development, a clearer understanding of the conditions will be obtained by an analysis of the statistics for the different varieties.

Arc lamps.—The statistics for the arc lamps are shown in Table 47.

TABLE 47.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—ARC LAMPS, BY KINDS: 1907 AND 1902.

KIND.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Total	[1]555,713	385,698	472,773	334,903	82,940	50,795	44.1	41.2	63.3
Open arcs	78,886	181,672	60,456	149,704	18,430	31,968	[2]56.6	[2]59.6	[2]42.3
Public	66,879	138,684	48,875	108,082	18,004	30,602	[2]51.8	[2]54.8	[2]41.2
Direct-current	64,416	134,054	47,207	105,401	17,209	28,653	[2]51.9	[2]55.2	[2]39.9
Alternating-current	2,463	4,630	1,668	2,681	795	1,949	[2]46.8	[2]37.8	[2]59.2
Commercial	12,007	42,988	11,581	41,622	426	1,366	[2]72.1	[2]72.2	[2]68.8
Direct-current	10,050	39,255	9,696	37,991	354	1,264	[2]74.4	[2]74.5	[2]72.0
Alternating-current	1,957	3,733	1,885	3,631	72	102	[2]47.6	[2]48.1	[2]29.4
Inclosed arcs	476,827	204,026	412,317	185,199	64,510	18,827	133.7	122.6	242.6
Public	222,512	73,041	167,434	58,641	55,078	14,400	204.6	185.5	282.5
Direct-current	68,500	29,608	54,066	23,006	14,434	6,602	131.4	135.0	118.6
Alternating-current	154,012	43,433	113,368	35,635	40,644	7,798	254.6	218.1	421.2
Commercial	254,315	130,985	244,883	126,558	9,432	4,427	94.2	93.5	113.1
Direct-current	126,251	67,180	125,150	66,104	1,101	1,076	87.9	89.3	2.3
Alternating-current	128,064	63,805	119,733	60,454	8,331	3,351	100.7	98.1	148.6

[1] Exclusive of 7,082 lamps used by the central stations to light their own electric properties.

[2] Decrease.

Notwithstanding a considerable increase in the total number of arc lamps—170,015, or 44.1 per cent—the gain has been at a slower rate than that for incandescent lamps. At the census of 1902 the arc lamp had reached a higher degree of development than the incandescent lamp, since in the early stages of the industry the demand for electricity was to a considerable extent influenced by its utility for street lighting, a branch of service which was at first confined to arc lamps. Now, however, the incandescent lamp has largely superseded the arc lamp for street and other lighting purposes, since it has been found that better service is secured

Digitized by Google

by the distribution of a larger number of comparatively small lamps than by the use of a few lamps of large candlepower. In fact, the relatively small gain in arc lamps may be accounted for by the much greater general usefulness of the incandescent lamp. The percentage of increase in the number of arc lamps was somewhat larger for the municipal than for the commercial stations. Inasmuch, however, as the total number of these lamps in municipal stations formed less than one-seventh of the total number in both branches of the service in 1902, and but little more than one-seventh in 1907, the percentage of gain is not of so much real significance. In this connection it may be of interest to note that, although at both censuses the municipal stations had a larger proportion of the total number of arc lamps than of the total number of incandescent lamps, the percentages being 14.9 for the former class and 9.8 for the latter in 1907, and 13.2 and 8.7 for the two classes, respectively, in 1902, the gains in the percentages were remarkably close, being 1.7 for the arc lamps and 1.1 for the incandescent lamps.

Since the census of 1902 the change then going on from the open arc to the inclosed has continued on a large scale. At that census the open-arc lamps which were of very limited length of continuous burning represented 47.1 per cent of the total number of arcs, but in 1907 the proportion had declined to 14.2 per cent. There was an actual decrease in the number of open-arc lamps of 102,786, or 56.6 per cent, and an increase in the number of inclosed-arc lamps of 272,801, or 133.7 per cent. These figures show conclusively that not only is the inclosed arc demanded in new work, but that the old equipment of open arcs has largely been replaced by the inclosed lamp. In 1902 of the open arcs reported 82.4 per cent were in commercial stations and 17.6 per cent in municipal stations, while the corresponding proportions for 1907 were 76 6 per cent and 23.4 per cent, respectively. The following tabular statement shows the per cent distribution, by kind, of arc lamps, for commercial and municipal stations, for the years 1907 and 1902:

Commercial and municipal central electric stations—Per cent distribution of arc lamps, by kind: 1907 and 1902.

KIND.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total	100.0	100.0	100.0	100.0	100.0	100.0
Open	14.2	47.1	12.8	44.7	22.2	62.9
Inclosed	85.8	52.9	87.2	55.3	77.8	37.1

The change from open to inclosed arc lamps has been accompanied by a decided change in the kind of current used in operating them.

TABLE 48.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—ARC LAMPS, BY KIND OF CURRENT USED: 1907 AND 1902.

KIND.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Total	[1] 555,713	385,698	472,773	334,903	82,940	50,795	44.1	41.2	63.3
Direct current	269,217	270,097	236,119	232,502	33,098	37,595	[2] 0.3	1.6	[2] 12.0
Alternating current	286,496	115,601	236,654	102,401	49,842	13,200	147.8	131.1	277.6

[1] Exclusive of 7,082 lamps used by central stations to light their own properties. [2] Decrease.

Of the total number of arc lamps in 1902, seven-tenths were direct-current, but in 1907 the corresponding proportion was less than one-half. The increase of 170,015 arc lamps between 1902 and 1907 is due wholly to the gain in the alternating-current lamps, since there was an actual loss of 880 in the number of those operated by direct current. The change in the character of current used has taken place somewhat more rapidly in municipal than in commercial stations.

TABLE 49.—*Commercial and municipal central electric stations—Per cent distribution of arc lamps, by kind of current used: 1907 and 1902.*

KIND.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total	100.0	100.0	100.0	100.0	100.0	100.0
Direct current	48.4	70.0	49.9	69.4	39.9	74.0
Alternating current	51.6	30.0	50.1	30.6	60.1	26.0

Incandescent lamps.—The incandescent lamps have become an important adjunct to business, and in some of its uses may be rightfully classed as necessary to comfort, although in other cases its use is a luxury. Spectacular and beautiful effects are produced with incandescent lamps in outdoor and indoor illumination, while electric signs in motion effects and in colors, and window and store decorations of great brilliancy are now common in all large centers. These features have become so important in central-station work that a special department devoted to this branch of the service is considered necessary by many of the larger companies. The developments along the lines of incandescent lighting have been wonderful and the possibilities seem almost limitless.

Various kinds of lamps which in 1902 were in a semiexperimental stage have since become of demonstrated merit, while new ones are continually being invented. In fact, so numerous and so desirable were many of these lamps that at the census of 1907 it was

Digitized by Google

decided to add an inquiry calling for the number of such lamps, and, although it is probable that some lamps of these classes were erroneously reported as incandescent lamps, 162,338 lamps of the special varieties were reported separately by the various central stations. In 1902 these types of lamps were probably included in the total number of incandescent lamps reported, and consequently their actual increase as given in Table 50 is less than it should be.

TABLE 50.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—INCANDESCENT LAMPS, BY CANDLEPOWER, AND OTHER VARIETIES OF LAMPS: 1907 AND 1902.

KIND.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Incandescent lamps	[1] 41,445,997	18,194,044	37,393,549	16,616,593	4,052,448	1,577,451	127.8	125.0	156.9
Sixteen-candlepower	35,640,612	15,557,843	32,153,240	14,126,123	3,487,372	1,431,720	129.1	127.6	143.6
Thirty-two-candlepower	1,408,610	574,667	1,242,415	531,309	166,195	43,358	145.1	133.8	283.3
All other candlepower	4,396,775	2,061,534	3,997,894	1,959,161	398,881	102,373	113.3	104.1	289.6
Other varieties of lamps—Nernst, vacuum, vapor, etc	[2] 162,338	([3])	153,468	([3])	8,870	([3])	.....	.....	.....

[1] Exclusive of 266,242 lamps used by the central stations to light their own electric properties.
[2] Exclusive of 1,755 lamps used by the central stations to light their own electric properties.
[3] Not reported separately.

The total number of incandescent lamps more than doubled between the censuses of 1902 and 1907, the increase being 23,251,953 lamps, or 127.8 per cent. Although this increase was mostly in 16-candlepower lamps, it also represents lamps varying from street lamps and those of 32 candlepower to the very small sign lamps. The increase is exclusive of 162,338 lamps of "other varieties," chiefly Nernst, and of 266,242 lamps used by the central stations to light their own properties.

The schedules used at both censuses were prepared in such a way that the number of incandescent lamps should be reported as of the following three classes: 16 candlepower, 32 candlepower, and all other candlepower. The wording of the inquiry was such as to ascertain the number of these lamps wired for service on December 31, or the last day of the period covered by the report, and not the actual number in use at different times during the year.

The continually decreasing practice of renting incandescent lamps for general commercial uses on a flat-rate basis and, as a consequence, the increasing use of meters to measure the amount of current consumed, render it no longer necessary in the majority of cases for the central stations to know the number of lamps wired for service or of machines in use, and although some companies reported the number of incandescent lamps, in accordance with the requirements of the schedule, many of the large companies claimed to have such limited knowledge of the number of these lamps wired for service that they were reluctant, and in some instances declined, to give even an estimate of the several varieties, but confined their answers to the inquiry to an estimate of the total number of incandescent lamps on a 16-candlepower basis. In view of these conditions, the results should be accepted only as an approximation of the total number of incandescent lamps wired for service and also of the classes by candlepower. The actual number of arc lamps was reported by practically all companies.

In 1907, 3,136 companies reported lamps of 32 candlepower. There were 956 companies that reported none of this size, either because they actually had none of this size or because they prepared their schedule for the estimated number of incandescent lamps on a 16-candlepower basis. The remaining 504 stations that had incandescent lamps wired for service, so far as their equipment in that respect is concerned, reported 16's and "other varieties" or only "other varieties." The 956 central stations which reported no lamps of 32 candlepower reported a total of 13,407,883 lamps of 16 candlepower, or nearly one-third of the incandescent lamps reported by all stations. In this connection, however, it should not be forgotten that many of the companies which reported lamps of 32 candlepower stated that the number was estimated.

An attempt was made by correspondence on the subject with a number of central stations to obtain the proper ratio by which to reduce the total number of incandescent lamps shown in Table 50 to lamps of a uniform 16 candlepower. Applying the same ratio of reduction to the total number of lamps of all other varieties, it was found that the total lamps in question were equivalent to 40,656,220 incandescent lamps of 16 candlepower in 1907, and to 17,737,944 in 1902, an increase of 22,918,276, or 129.2 per cent. The difference of increase, as shown in Table 50 and as estimated on a basis of 16 candlepower, is smaller than might be expected, 333,677, or but little more than 1 per cent.

More than nine-tenths of the incandescent lamps were reported at each of the two censuses by the commercial stations, the actual proportions contributed by the municipal stations being 9.8 per cent in 1907 and 8.7 per cent in 1902.

Digitized by Google

The following statement shows the number of central stations, classified according to the kind of lamps wired for service, December 31, 1907:

Central electric stations—Number, by lamp equipment: 1907.

Total number of stations	4,714
With incandescent lamps	4,596
With lamps of 32 candlepower	3,136
With lamps of 16 candlepower only[1]	956
Without incandescent lamps	118
With arc lamps	3,700
Without arc lamps	1,014
Without either incandescent or arc lamps	68

[1] These 956 stations reported nearly one-third of the total number of incandescent lamps, and most of them reported only an estimate of the number of lamps on a 16-candlepower basis, because it was impracticable to answer the inquiries on the schedule in detail.

The increase in the use of electric light and the importance of the industry may perhaps be illustrated most satisfactorily by comparing the number of lamps with the population. Such a comparison is made in Table 51 for the 8 states that contained the largest number of incandescent lamps in 1907 and 1902.

The striking features of this table are the concentration in a comparatively few states of a large proportion of the electric lamps, and the great increase in the average number of lamps per 1,000 population. The 8 states here shown contained nearly two-thirds of the total number of both arc and incandescent lamps, the proportions for the two classes being practically the same, but represented a considerably smaller proportion of the total population, which fact merely illustrates the larger general use of the electric light in the thickly settled communities. Of the 8 states, Missouri shows the lowest and California the highest average number of lamps per 1,000 population. The population of Missouri is more than twice as great as that of California, but it is evident that the electrical development there has not reached the importance that it has in California. Both states contain a considerable proportion of rural population, which has been supplied with electricity more generally in California than in Missouri. In California a number of hydro-electric plants have been established throughout the state, primarily to supply current to large cities located at a distance, but these plants also supply intervening smaller places for which electricity might not otherwise be available. This condition contributes naturally toward the more extensive use of the electric light and an increase in the number of lamps. Although California holds a low comparative rank in population, it being the twenty-first state, it ranks fourth in the number of incandescent lamps and ninth in the number of arc lamps. In 1902 the state ranked fifth in the number of incandescent lamps and seventh in the number of arc lamps. Next to California, which has the smallest population of the 8 states shown in Table 51, New York, which is the most populous state of the Union, has the greatest average number of arc lamps per 1,000 inhabitants, and Massachusetts, the third largest average for arc lamps and the second largest for incandescent lamps.

TABLE 51.—CENTRAL ELECTRIC STATIONS—ARC AND INCANDESCENT LAMPS, FOR THE 8 STATES HAVING THE LARGEST NUMBERS OF INCANDESCENT LAMPS: 1907 AND 1902.

STATE.	ARC LAMPS.		INCANDESCENT LAMPS.		PER CENT DISTRIBUTION.				AVERAGE NUMBER OF LAMPS PER 1,000 POPULATION.			
					Arc lamps.		Incandescent lamps.		Arc lamps.		Incandescent lamps.	
	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902	1907	1902
Total for United States	555,713	385,698	41,445,997	18,194,044	100.0	100.0	100.0	100.0	6.50	4.91	484.57	231.55
Total for selected states	358,114	252,316	25,817,953	11,817,849	64.4	65.4	62.3	65.0	9.89	7.55	712.99	353.46
New York	97,529	59,130	6,991,406	3,705,525	17.6	15.3	16.9	20.4	11.63	7.85	833.63	491.90
Pennsylvania	66,777	47,722	3,861,171	1,783,683	12.0	12.4	9.3	9.8	9.49	7.34	549.01	274.16
Illinois	55,309	38,215	3,582,178	1,567,665	10.0	9.9	8.6	8.6	10.02	7.61	649.16	312.31
California	19,691	15,764	3,067,383	1,006,875	3.5	4.1	7.4	5.5	11.75	10.25	1,831.04	654.73
Massachusetts	33,809	28,790	2,650,724	1,420,963	6.1	7.5	6.4	7.8	10.99	9.87	859.78	487.00
Ohio	43,849	31,839	2,254,467	934,213	7.9	8.3	5.4	5.1	9.75	7.49	501.30	219.69
Michigan	23,514	17,712	1,711,689	805,127	4.2	4.6	4.1	4.4	9.00	7.14	655.37	324.55
Missouri	17,576	13,144	1,698,935	593,798	3.2	3.4	4.1	3.3	5.16	4.12	498.82	186.32

The largest increases in the number of arc lamps are shown for New York, Pennsylvania, Illinois, Ohio, Indiana, New Jersey, Michigan, and Massachusetts. For the incandescent lamps large increases occur in so many states that it is difficult to select any as showing the greatest development, but in the following states the numbers for 1907 are at least three times as great as for 1902: Alabama, California, Idaho, Kansas, Kentucky, Maryland, Nebraska, Nevada, North Carolina, Oklahoma, Oregon, South Carolina, and Washington. While these 13 states show the greatest proportional increases in the number of lamps, they do not represent the largest absolute increases, as their combined increase is exceeded by the gain in the total for the 2 states of New York and Pennsylvania.

The 162,338 lamps reported as "other varieties" in 1907 include those that were considered by certain of the establishments reporting as not properly belonging to the first group of incandescents. These

Digitized by Google

new types of lamps were not reported separately at the census of 1902, and, as already stated, it is probable that in 1907 lamps that properly should have been assigned to this group were included by many stations in the total for incandescent lamps. The total for 1907, however, included a number of the new varieties of lamps and, although thought to be far from complete, they are shown in the following statement:

Central electric stations—Lamps other than regular arc and incandescent, by kind: 1907.

KIND OF LAMP.	Number.
Total	162,338
Nernst	124,899
Meridian	5,214
Gem	3,343
Tantalum	2,467
Vapor	1,282
Tungsten	582
Vacuum	138
Not designated	24,413

The central stations were requested to name the lamps other than the regular arc and incandescent, but some reported a number without any designation, and the 24,413 "Not designated" no doubt include some that might properly have been assigned to one or more of the other groups.

The use of electric lamps for advertising and decorative purposes has resulted in greatly increasing the varieties in use, and has also added to the difficulty of ascertaining the actual number wired for service on a given date. It was impossible, therefore, with a fair degree of accuracy to show separately the number of 16, 32, and other candlepower incandescent lamps, as was done at the census of 1902. However, the schedule used at the census of 1907 required that the number of 32-candlepower lamps wired for service be reported separately, and 3,136 stations reported 1,408,610, while the same stations reported a total of 27,248,337 incandescent lamps of all varieties. Using the ratio of these totals as a basis, the estimated number of 32-candlepower lamps wired for service at the close of 1907 was about 2,112,915.

Meters on consumption circuits.—It was impracticable to obtain statistics concerning the size of the meters in service, and therefore the extension of the service can be shown only by the number of meters. That the number has increased rapidly since 1902 is shown by Table 52.

TABLE 52.—CENTRAL ELECTRIC STATIONS—METERS ON CONSUMPTION CIRCUITS, FOR THE 8 STATES HAVING THE GREATEST NUMBERS OF METERS: 1907 AND 1902.

STATE.	TOTAL NUMBER.		Per cent of increase.	AVERAGE NUMBER PER STATION.		NUMBER OF CUSTOMERS FURNISHED CURRENT.[1]	AVERAGE NUMBER OF METERS PER CUSTOMER.[1]
	1907	1902		1907	1902	1907	1907
Total for United States	1,683,917	582,689	189.0	357.2	161.0	1,946,979	0.9
Total for selected states	981,461	361,230	171.7	495.9	209.5	1,057,853	0.9
New York	217,462	73,789	194.7	692.6	288.2	201,701	1.1
Illinois	146,208	59,836	144.3	381.7	172.9	167,645	0.9
California	143,384	34,224	319.0	1,111.5	297.6	173,029	0.8
Pennsylvania	142,186	56,874	150.0	434.8	203.8	160,957	0.9
Ohio	92,964	31,508	195.0	341.8	135.2	100,071	0.9
Massachusetts	87,824	56,969	54.2	731.9	499.7	80,713	1.1
Michigan	78,950	29,272	169.7	337.4	145.6	87,500	0.9
Indiana	72,483	18,758	286.4	362.4	104.2	86,237	0.8

[1] Information not available for 1902.

The gain of 189 per cent in the number of meters no doubt indicates fairly well how complete the change has been from the flat-rate method of charging, so largely used at the earlier period of electric-station work, to the use of meters. There have been many and important changes in central-station practice during the short period between the two censuses, but none is more important, from the commercial point of view, than the general adoption of meter rates.

To obtain the total number of meters used for the sale of electricity it is necessary to add to the number shown in Table 52, the number on the consumers' circuits of electric-railway companies. There were 213,886 meters reported by such companies in 1907 and 56,601 in 1902, making the aggregates for the two censuses 1,897,803 and 639,290, respectively, showing an increase of 1,258,513, or 196.9 per cent.

The 8 states represented in this table are those in which central stations have had the greatest development in the installment of meters, and contained 58.3 per cent of the total number of meters reported for all central stations in 1907 and 62 per cent of the total reported for 1902. The percentages of increase and the average number per customer indicate, however, that the practice has become very general.

The average number of meters per station is to some extent misleading because of differences due to peculiar conditions in certain states. In California, for instance, there is one company which generates electric current at a long distance from the main point of distribution

Digitized by Google

and supplies it to towns and cities in 22 counties, whereas a service of this sort in other states probably would be represented by a number of separate stations, so that the average number of meters per station would be considerably smaller. Probably the best indication of the growth in the use of meters may be had from the fact that of the 4,714 stations in 1907 only 629, or 13.3 per cent of the total, reported no meters, while in 1902, of a total of 3,620 stations, 901, or 24.9 per cent, reported none. The mechanical meter has now come into such general use that the number of chemical and other varieties of meters were not reported separately in 1907 as they were in 1902.

Transformers in circuits for customers.—The increased use of alternating dynamos has necessarily been accompanied by an increase in the number of machines for lowering the pressure of the circuit. Step-down alternating-current transformers are in general use where alternating dynamos are employed.

TABLE 53.—CENTRAL ELECTRIC STATIONS—NUMBER AND KILOWATT CAPACITY OF TRANSFORMERS IN CIRCUITS FOR CUSTOMERS, FOR THE 8 STATES HAVING THE GREATEST KILOWATT CAPACITY: 1907 AND 1902.

STATE.	1907		1902		Per cent of increase in kilowatt capacity.	PER CENT OF TOTAL KILOWATT CAPACITY.		AVERAGE CAPACITY.	
	Number.	Kilowatt capacity.	Number.	Kilowatt capacity.		1907	1902	1907	1902
Total for United States	299,489	2,058,567	207,370	687,121	199.6	100.0	100.0	6.9	3.3
Total for selected states	169,674	1,326,338	113,046	425,715	211.6	64.4	62.0	7.8	3.8
New York	32,466	496,046	18,036	142,383	248.4	24.1	20.7	15.3	7.9
California	21,625	213,633	9,480	49,368	332.7	10.4	7.2	9.9	5.2
Pennsylvania	37,578	195,742	29,005	62,258	214.4	9.5	9.1	5.2	2.1
Illinois	20,331	99,067	15,040	46,515	113.0	4.8	6.8	4.9	3.1
Massachusetts	16,165	94,324	12,284	41,786	125.7	4.6	6.1	5.8	3.4
Ohio	18,991	91,064	11,925	34,600	163.2	4.4	5.0	4.8	2.9
Michigan	10,222	72,663	7,695	26,995	169.2	3.5	3.9	7.1	3.5
Indiana	12,296	63,799	9,581	21,810	192.5	3.1	3.2	5.2	2.3

The figures in this table represent only the transformers owned by the central stations. The number used by electric-railway companies was not reported at either census. As transformers are sometimes owned by the customers, the total shown in the table, 299,489, is somewhat less than the actual number used in connection with central-station service. The number of machines has, however, increased rapidly since 1902, but not so fast as their kilowatt capacity. This condition is due primarily to the fact that the old-style transformers in use in 1902 have been largely replaced by machines of much larger capacity, the average capacity per machine having more than doubled during the five years ending with 1907.

There were 1,126 stations in 1907 and 967 in 1902 that reported no transformers in use, the proportions being 23.9 and 26.7 per cent of the total number of stations at the respective censuses.

Stationary motors.—The schedule used at the census of 1902 called for the number of all kinds of stationary motors, including fan motors, while that for 1907 expressly excluded the latter class. No doubt many fan motors were reported at the census of 1902, but to what extent it is impossible to ascertain.

It was often extremely difficult to ascertain the horsepower capacity of the motors, the current to operate which was sometimes transmitted long distances to factories where the interest of the central station furnishing the electricity was confined to the amount of current consumed as measured by the meters. It was necessary, therefore, to obtain estimates of the number and capacity of the motors. These estimates were included in the totals given in Table 54, which shows, for the United States and for the 8 states reporting the greatest horsepower capacity, the number and capacity of all stationary motors reported at the two censuses.

Next to lighting, stationary-motor service is the most important source of income for central electric stations, but the introduction of meters has complicated the difficulties attending the collection of statistics concerning the number and capacity of the motors. It is probable, therefore, that the totals in Table 54 are somewhat less than the actual number of motors wired at the end of the respective census years. Many large factories have the machinery operated entirely by electric power and some contain many motors for which statistics had to be obtained from the manufacturers, as the central stations were concerned only with the quantity of current sold.

As shown by Table 45, there were a number of stationary motors supplied with current by electric-railway companies which must be considered in arriving at the totals for this class of service. The figures in Table 54 indicate that the average size of the motors in the central stations has more than doubled since 1902, while the number increased by only 65.4 per cent, a difference in ratio of increase which is without doubt due to the fact that some large central stations reported the horsepower of the motors for which current was

Digitized by Google

supplied but expressed their inability to give even an estimate of the number of machines. This condition was pronounced in Pennsylvania, where the increase in the average capacity of the motors was exceptionally large—from 2.16 horsepower in 1902 to 12.17 horsepower in 1907. One large company in this state reported nearly one-third of its total stationary-motor power but was unable to state the number of motors.

TABLE 54.—CENTRAL ELECTRIC STATIONS—NUMBER AND HORSEPOWER CAPACITY OF STATIONARY MOTORS, FOR THE 8 STATES HAVING THE GREATEST HORSEPOWER CAPACITY: 1907 AND 1902.

STATE.	1907		1902		AVERAGE CAPACITY.		Per cent of increase in horsepower.	PER CENT OF TOTAL HORSEPOWER.	
	Number.	Horsepower.	Number.	Horsepower.	1907	1902		1907	1902
Total for United States	167,184	1,649,026	101,064	438,005	9.86	4.33	276.5	100.0	100.0
Total for selected states	106,321	1,107,687	67,037	309,655	10.42	4.62	257.7	67.2	70.7
New York	18,051	393,955	13,581	109,277	21.82	8.05	260.5	23.9	24.9
California	11,560	200,067	5,190	50,296	17.31	9.69	297.8	12.1	11.5
Illinois	21,675	137,661	11,838	35,928	6.35	3.03	283.2	8.3	8.2
Pennsylvania	10,063	122,461	14,144	30,560	12.17	2.16	300.7	7.4	7.0
Massachusetts	15,877	81,246	9,663	35,749	5.12	3.70	127.3	4.9	8.2
Ohio	13,083	64,941	5,704	21,956	4.96	3.85	195.8	3.9	5.0
Missouri	8,923	54,111	4,646	14,552	6.06	3.13	271.8	3.3	3.3
Michigan	7,089	53,245	2,271	11,337	7.51	4.99	369.7	3.2	2.6

The state of California, although having a comparatively small population, ranks second in the horsepower of its stationary-motor service, being outranked only by New York. This high rank is due to the scarcity of fuel in the state; the ease with which electric power may be transmitted and made available in sparsely settled sections; and its adaptability for use on dredgers and for many other purposes connected with mining and irrigation.

Modern central-station companies concern themselves little with the various uses made of the current sold. The quantity is measured, and as a rule the producers make no inquiry as to its use. Electricity is used for a multitude of miscellaneous purposes which consume, however, but a small proportion of the amount generated, much the larger portion being used for light and power. Table 55 shows the number of stations which sold current for the various purposes during the years 1907 and 1902.

TABLE 55.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER OF STATIONS, BY CHARACTER OF SERVICE: 1907 AND 1902.

CHARACTER OF SERVICE.	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.		
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.
Arc lighting:									
Commercial	2,381	2,020	1,840	1,667	541	353	17.9	10.4	53.3
Public	3,298	2,522	2,206	1,810	1,092	712	30.8	21.9	53.4
Incandescent lighting:									
Commercial	4,538	3,484	3,385	2,752	1,153	732	30.3	23.0	57.5
Public	3,345	2,491	2,327	1,889	1,018	602	34.3	23.2	69.1
Motor power:									
Stationary	2,009	1,093	1,659	975	350	118	83.8	70.2	196.6
Electric-railway	217	159	211	157	6	2	36.5	34.4	200.0
All other electric service	999	161	831	152	168	9	520.5	446.7	1,766.7

There were only 68 central stations in 1907 which reported that the entire amount of electricity generated during the year was sold for motor service, disposed of in bulk to other electric or railway companies, or sold for some purpose other than lighting; all the other stations reported the sale of current for lighting. That electric lighting is the chief business of the central stations is shown also by the fact that of the total income, almost three-fourths was from lighting and about one-sixth from stationary-motor service.

Average size of station.—The number of lamps, meters, transformers, and motors is an indication of the size of the central station, and averages based on the numbers of these machines are given in Table 56.

Digitized by Google

TABLE 56.—*Commercial and municipal central electric stations—Average number of lamps, meters, transformers, and motors per station and average capacity per machine: 1907 and 1902.*

	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Arc lamps:						
Average number per station	118	107	137	119	66	62
Incandescent lamps:						
Average number per station	8,792	5,026	10,801	5,924	3,237	1,936
Meters on consumption circuits:						
Average number per station	357	161	424	188	172	70
Transformers in circuits for customers:						
Average number per station	64	57	74	64	35	34
Kilowatt capacity per machine	7	3	7	3	4	3
Kilowatt capacity per station	437	190	548	218	129	92
Stationary motors:						
Average number per station	35	28	47	35	4	2
Horsepower per motor	10	4	10	4	7	2
Horsepower per station	350	121	467	155	25	4

Although there are conflicting elements entering into the details from which these totals are obtained, the figures are of sufficient accuracy to establish the fact that the averages for 1907 show great increases over the averages for 1902.

Line construction.—The report on central electric stations for 1902 presents statistics for 125,144.14 miles of mains and feeders contained in overhead, underground, and submarine construction. Comparatively few companies, however, had definite knowledge of the miles of wire strung, and it was exceedingly difficult to obtain satisfactory answers to the census inquiries on the subject. In 1907, therefore, the inquiry on the subject was confined to the single question as to the number of miles of street occupied by underground conduits for mains and feeders, for which a total of 2,509.15 miles was reported. Of this total, 2,268.34 miles were reported by commercial stations and 240.81 miles by municipal stations.

Digitized by Google

CHAPTER V.

CAPITALIZATION.

Basis of statistics.—The statistics of capitalization of central electric light and power stations are confined to the par value of the authorized and outstanding preferred and common stock and bonds of commercial corporations, the par value of the bonds issued by municipalities to secure funds for the construction, purchase, or operation of the municipal stations, and the returns made on such capitalization in the form of dividends or interest. For 909 stations owned by individuals, private companies, or cooperative associations, which were not incorporated and had no stock, no statistics of capitalization could be reported. In addition, 21 companies which operated both electric light and power stations and electric railways reported their entire capitalization in connection with the inquiry on street railways; 9 stations, which are reported separately in the tables showing the number of companies, represent stations owned by corporations operating other stations which reported the capitalization of these 9 stations in the same or another state; while 7 companies did not report capitalization. In the cases of 254 municipal stations, bonds originally issued by the city to secure funds for their construction, purchase, or operation had been retired, and for this or other reasons no statistics of capitalization could be secured. Deducting these plants, there remain 2,516 commercial and 998 municipal stations for which statistics of capitalization are shown.

Increase since 1902.—A presentation of statistics as to the capital stock, funded debt, dividends, and interest on funded debt of all companies and municipal stations having outstanding investment securities is given for 1907 and 1902 in Table 57.

Although the number of municipal stations having outstanding bonds was relatively larger in 1907 than in 1902—constituting 28.4 per cent of the aggregate number of companies and municipal stations reporting capital stock or funded debt in 1907 compared with 24.3 per cent in 1902—the funded debt of the municipal stations constituted but 4 per cent of the total funded debt in 1907 as compared with 4.4 per cent in 1902. The aggregate amount of interest paid on funded debt was $27,991,762 in 1907 and $12,623,545 in 1902, the interest on the municipal bonds constituting 4.1 per cent of the former amount and 4 per cent of the latter amount. The funded debt of the municipal stations represented 1.9 per cent of the total capitalization outstanding in both 1907 and 1902.

TABLE 57.—*Capital stock, funded debt, dividends, and interest paid on funded debt of commercial companies, and funded debt and interest of municipal stations having bonds outstanding: 1907 and 1902.*

	1907	1902	Per cent of increase.
Number of commercial companies and municipal stations having outstanding capitalization	3,514	2,705	29.9
Commercial companies	[1] 2,516	2,049	22.8
Municipal stations reporting bonds outstanding	998	656	52.1
Total capitalization outstanding	$1,367,338,836	$639,125,363	113.9
Capital stock	741,317,497	372,951,952	98.8
Funded debt	626,021,339	266,173,411	135.2
Commercial companies:			
Total capitalization outstanding	1,341,995,182	627,515,875	113.9
Capital stock—			
Authorized, par value	900,092,160	435,178,372	106.8
Common	798,873,386	407,807,934	95.9
Preferred	101,218,774	27,370,438	269.8
Outstanding, par value	741,317,497	372,951,952	98.8
Common	666,003,772	349,080,281	90.8
Preferred	75,313,725	23,871,671	215.5
Dividends, amount	19,300,572	6,189,837	211.8
On common stock	16,883,812	5,560,341	203.6
On preferred stock	2,416,760	629,496	283.9
Funded debt—			
Authorized, amount	815,516,672	308,117,894	164.7
Outstanding, amount	600,677,685	254,563,923	136.0
Interest	26,842,330	12,118,740	121.5
Municipal stations:			
Funded debt—			
Authorized, amount	29,031,638	12,625,482	129.9
Outstanding, amount	25,343,654	11,609,488	118.3
Interest	1,149,432	504,805	127.7

[1] Exclusive of 37 companies (21 operating electric railways with capitalization included in report for street and electric railways; 9 duplications due to corporations reporting capitalization in one state and owning establishments in another state, which are reported separately in certain of the tables; and 7 not reporting capitalization for sundry reasons), but including 2 companies reporting bonds only, their capital stock not being separable from other interests.

Capitalization of commercial companies.—While the capitalization of the commercial companies shows a large increase from 1902 to 1907—the total outstanding capitalization increasing 113.9 per cent—this increase is in harmony with the growth in the production of electricity as indicated by the increase in kilowatt output for these stations, which was 141.1 per cent. Of the total outstanding capitalization of the commercial companies in 1907, 55.2 per cent represented capital stock compared with a corresponding percentage of 59.4 in 1902, and 44.8 per cent represented funded debt as compared with a corresponding percentage of 40.6 in 1902. That is, the proportion of the total capitalization represented by capital stock has been appreciably reduced, while that represented by funded debt has increased. This falling off in the relative importance of capital stock is confined to common stock, which formed 49.6 per cent of the total capitalization in 1907 compared with 55.6 per cent in 1902, while the proportion represented by preferred stock increased from 3.8 per cent of the total capitalization in 1902 to

Digitized by Google

5.6 per cent in 1907. The average outstanding capitalization per system increased in harmony with the general growth. For 1907 the average total capitalization per system was $533,384 compared with $306,255 in 1902, or a general average increase of 74.2 per cent. These averages represent an average amount of capital stock outstanding per system in 1907 of $294,641 compared with $182,017 in 1902, or an average increase of 61.9 per cent; and an average amount of funded debt in 1907 of $238,743 compared with $124,238 in 1902, or an average increase of 92.2 per cent.

The aggregate amount of funded debt shows an increase of 136 per cent compared with an increase of 98.8 per cent for capital stock. Though there was an increase of 215.5 per cent in the par value of preferred stock outstanding, the average increase for all stock is much smaller, owing to the lower rate of increase for common stock. The very satisfactory condition of the industry is evidenced by the increase in average dividend rates and the decrease in the average interest rate. The interest paid represents an average rate of 4.47 per cent on the total amount of outstanding funded debt in 1907 compared with an average rate of 4.76 per cent in 1902, and the dividends paid represent an average rate of 2.6 per cent in 1907 on the total amount of outstanding stock compared with an average rate of 1.66 per cent in 1902; while the total amount of dividends and interest paid in 1907 represents an average rate of 3.44 per cent on the total volume of outstanding securities, including both stocks and bonds, compared with an average rate of 2.92 per cent in 1902. The funded debt reported in 1907, however, includes $9,270,800 upon which no interest was paid. Eliminating this debt the average rate of interest upon the funded debt of the commercial companies upon which interest was paid becomes 4.54 per cent, which is the same as the average rate of interest for the outstanding bonds of the municipal stations. The allied industries tend to confuse all the statistics for the central electric stations, but especially those relating to capitalization. They make it difficult to draw any conclusion for the industry as a whole in regard to the increase in capitalization as compared with the increase of equipment, expenses, and income. It is significant, however, that of the 2,049 commercial companies having outstanding capitalization in 1902, only 41 reported the payment of dividends on preferred stock and 561 the payment of dividends on common stock; while of the 2,516 companies having outstanding capitalization in 1907, there were 101 which paid dividends on preferred stock and 661 which paid dividends on common stock. The average rate of dividend on preferred stock for the companies which paid dividends on such stock in 1907 was 5.39 per cent and in 1902, 5.16 per cent. The average rate on common stock for companies which paid dividends on common stock in 1907 was 5.25 per cent and in 1902, 4.4 per cent.

In this connection a comparison of the average return on the capitalization of the central electric light and power stations with that for the other electrical industries which represent public utilities may be of interest. The following statement shows the average rate per cent which the interest paid on funded debt and dividends paid on capital stock represent on the total outstanding capitalization of the incorporated companies in the electric light and power, street and electric railway, and telegraph and telephone industries. It should be borne in mind, however, that these rates are computed on the total outstanding capitalization, including that upon which no dividends or interest were paid.

Average rate of return on capitalization of incorporated companies: 1907 and 1902.

INDUSTRY.	AVERAGE RATE, PER CENT.	
	1907	1902
Central electric light and power stations	3.44	2.92
Street and electric railways	3.34	3.32
Telegraph and telephone companies	4.46	5.23

The average rate of return on outstanding capitalization in 1902 was larger both for street and electric railways and for telegraph and telephone companies than for commercial companies operating central electric light and power stations, but in 1907 the latter class of companies reported a higher average rate than did the street and electric railways, though this rate was still exceeded by the average rate for the telegraph and telephone industries.

Capitalization of purely electric and composite companies.—The report for 1902 does not permit a comparative presentation to be made for the two censuses in respect to the capitalization of commercial companies classified according to the character of the business done, but in 1902, 1,302 of the 2,049 commercial companies having outstanding capitalization, or 63.5 per cent, were purely electric and 747, or 36.5 per cent, were composite. A further idea as to the probable distribution of the total capitalization between the two classes of companies in 1902 may be gained from the statistics in reference to interest, the interest payments of the purely electric companies amounting to $8,767,252, or 72.3 per cent of the total interest paid on funded debt, while those of the composite companies amounted to $3,351,488, or 27.7 per cent of the total interest on funded debt. From Table 58, which gives the distribution of capitalization between the purely electric and the composite companies in 1907, it will be seen that the capitalization of companies engaged exclusively in the generation and sale of electric current formed only 49.1 per cent of the total capitalization of all incorporated companies for which statistics were secured.

Digitized by Google

TABLE 58.—*Purely electric and composite companies—Capital stock, funded debt, dividends, and interest: 1907.*

	All companies.	Purely electric companies.	Composite companies.	PER CENT OF TOTAL.	
				Purely electric.	Composite.
Number of companies	2,516	1,542	974	61.3	38.7
Total capitalization outstanding	$1,341,995,182	$659,206,602	$682,788,580	49.1	50.9
Capital stock outstanding, par value	741,317,497	375,681,037	365,636,460	50.7	49.3
Common	666,003,772	348,191,966	317,811,806	52.3	47.7
Preferred	75,313,725	27,489,071	47,824,654	36.5	63.5
Dividends, amount	19,300,572	11,072,882	8,227,690	57.4	42.6
On common stock	16,883,812	10,312,935	6,570,877	61.1	38.9
On preferred stock	2,416,760	759,947	1,656,813	31.4	68.6
Funded debt outstanding, amount	600,677,685	283,525,565	317,152,120	47.2	52.8
Interest	26,842,330	12,296,086	14,546,244	45.8	54.2

The total capitalization is fairly well distributed between the two classes of companies, though the purely electric companies greatly outnumber the composite companies. It will be observed, however, that the composite companies reported nearly two-thirds of the preferred stock outstanding.

In Table 58 and all other tables containing statistics of capitalization the total capital stock and funded debt of each company are included, except where specially noted, but it is manifest that a considerable proportion of this capitalization is not properly chargeable to the central electric stations. All companies which reported the operation of an electric station in connection with some other industry and which kept no distinctive capital account, furnished an estimate as to the proportion of the outstanding capitalization which was chargeable to the electric light and power department. These estimates ranged from 1 to 99 per cent, depending upon the relative importance of the electric portion of the business. By means of a computation based upon these estimates the sum of $381,958,476 is obtained as the estimated par value of the capitalization represented by the electric portion of the business of the companies classified as composite. In addition, a small portion of the capitalization of the companies in the purely electric class, amounting to $5,681,307, is, in like manner, chargeable to other than electric light and power interests, making the capitalization of this class of companies which is chargeable to electric stations $653,525,295. By combining these two amounts, $1,035,483,771 is obtained as the capitalization chargeable to the central electric light and power stations, instead of $1,341,995,182, as shown in Table 58, the difference of $306,511,411 being the estimated capitalization not chargeable to the electric stations, but representing industries carried on in connection with the electric light and power industry, such as gas and ice plants, waterworks, sawmills, steam heating, mines, quarries, etc. Table 59 shows for 1907 this distribution of capitalization and the dividends and interest chargeable, respectively, to the electric light and power industry and to the allied industries.

TABLE 59.—DISTRIBUTION OF CAPITALIZATION, DIVIDENDS, AND INTEREST BETWEEN THE ELECTRIC LIGHT AND POWER INDUSTRY AND ALLIED INDUSTRIES: 1907.

	Capitalization.	DIVIDENDS AND INTEREST.				PER CENT DISTRIBUTION.			
		Total.		Dividends.	Interest.	Capitalization.	Dividends and interest.		
		Amount.	Average rate, per cent.				Total.	Dividends.	Interest.
Total	$1,341,995,182	$46,142,902	3.44	$19,300,572	$26,842,330	100.0	100.0	100.0	100.0
Electric light and power industry	1,035,483,771	35,803,408	3.46	15,159,573	20,643,835	77.2	77.6	78.5	76.9
Purely electric companies	653,525,295	23,241,772	3.56	11,030,537	12,211,235	48.7	50.4	57.2	45.5
Composite companies, chargeable to electric light and power industry	381,958,476	12,561,636	3.29	4,129,036	8,432,600	28.5	27.2	21.4	31.4
Allied industries	[1] 306,511,411	10,339,494	3.37	4,140,999	6,198,495	22.8	22.4	21.5	23.1

[1] Includes $5,681,307 reported for companies classified as purely electric, upon which dividends and interest amounting to $127,196 were paid as follows: Dividends, $42,345; interest, $84,851.

Of the total capitalization, 77.2 per cent is chargeable to the electric light and power industry and 22.8 per cent to other interests. Although the returns on capitalization have been distributed for the reports on composite plants according to the estimated proportion of the outstanding capitalization chargeable to the electric light and power plant department, yet this is an assumption that may or may not be correct and undoubtedly will not hold good in many cases. In some instances these allied industries may be conducted at a loss and the bond interest and dividends, if any, be paid from the profits of the electric plant; in others the electric plant may be operated at a loss and the interest and dividends be paid from the profits of the allied industries. The Census Bureau collected no statistics concerning profits on the year's business or the source of the money expended in the payment of interest or dividends.

Digitized by Google

Capitalization and cost of construction.—The capitalization reported does not include promissory notes and other temporary obligations, which in some instances amount to considerable sums. On the other hand, the stock and bonds were in some instances sold for less than the par value, and therefore the par value is correspondingly greater than the actual amount invested. There are also cases in which the market value of the stock is considerably in excess of the par value. In any event the capitalization as reported to the Census Bureau should not be accepted as representing the cash actually invested, as it by no means represents cost of physical equipment, etc., but includes earning capacity, good will, etc. In spite of this fact, however, the aggregate capitalization reported approximates very closely the amount reported as cost of plant. The 2,516 commercial companies reported $1,027,182,892 as the cost of plant, which includes land, buildings, machinery, tools and implements, overhead and underground construction, lamps, motors, meters, transformers wired for use, and all supplies on hand. Although the total capitalization of these companies amounts to $1,341,995,182, yet if the estimated amount chargeable to the allied interests, $306,511,411, is deducted, the balance of $1,035,483,771 chargeable to the electric light and power industry approximates very closely the amount reported as cost of plant, the difference being but eight-tenths of 1 per cent.

Many companies as they now exist are consolidations of other companies. In some instances a portion or all of the capitalization of the subsidiary companies has been retired, but frequently the entire capitalization of both the parent and subsidiary companies is included in the census reports. A portion of this capitalization is undoubtedly based on the earning capacity rather than on the actual value of the plant or the amount of cash invested. On the other hand, the application of earnings to new construction and betterments tends to lower the ratio of capitalization to cost of construction.

Analysis of dividends and interest.—The return on capital invested is, from a financial standpoint, the matter of chief interest in connection with capitalization and the most important statistics on this subject for 1907 are therefore assembled in Table 60.

Of the 2,516 incorporated companies having outstanding capitalization, 183, or 7.3 per cent, reported preferred stock, and 1,129, or 44.9 per cent, reported funded debt. In the aggregate, returns in the form of dividends or interest were made on a capitalization of $957,741,023, or 71.4 per cent of the total amount outstanding, this comprising $321,509,301 of common stock, or 48.3 per cent of the total common stock outstanding; $44,824,837 of preferred stock, or 59.5 per cent of the total preferred stock outstanding; and $591,406,885 of funded debt, this latter amount representing all of the funded debt, except $9,270,800 upon which interest was not paid.

The very close correspondence between the average rates of dividends on dividend-paying common and preferred stocks is a noticeable feature. The average rate of dividends on the dividend-paying common stock was 5.25 per cent, and on the dividend-paying preferred stock 5.39 per cent. As already stated, the average rate of interest on funded debt on which interest was paid was 4.54 per cent.

TABLE 60.—*Analysis of dividends and interest: 1907.*

Number of companies	[1] 2,516
Common stock:	
Number of companies reporting	2,514
Number of companies declaring dividends	661
Amount outstanding, par value	$666,003,772
Amount on which dividends were declared	$321,509,301
Per cent dividend-paying stock forms of all common stock	48.3
Amount of dividends	$16,883,812
Average rate of dividends on all common stock, per cent	2.54
Average rate of dividends on dividend-paying common stock, per cent	5.25
Preferred stock:	
Number of companies reporting	183
Number of companies declaring dividends	101
Amount outstanding, par value	$75,313,725
Amount on which dividends were declared	$44,824,837
Per cent dividend-paying stock forms of all preferred stock	59.5
Amount of dividends	$2,416,760
Average rate of dividends on all preferred stock, per cent	3.21
Average rate of dividends on dividend-paying preferred stock, per cent	5.39
Funded debt:	
Number of companies reporting	1,129
Number of companies paying interest	1,078
Amount outstanding	$600,677,685
Amount on which interest was paid	$591,406,885
Amount of interest	$26,842,330
Average rate of interest, per cent	4.54

[1] Including 2 companies reporting bonds only, their capital stock not being separable from other interests.

Table 61 shows the capitalization of the companies paying either dividends on stock or interest on funded debt and of those which made no return on capitalization.

TABLE 61.—*Capitalization—Amount, dividends, and interest for companies paying either dividends on stock or interest on funded debt, and amount for companies paying neither dividends nor interest: 1907.*

	COMPANIES REPORTING CAPITALIZATION.		
	Total.	Companies paying either dividends on stock or interest on funded debt.	Companies paying neither dividends on stock nor interest on funded debt.
Number of companies	[1] 2,516	1,496	1,020
Capitalization:			
Amount outstanding, par value	$1,341,995,182	$1,275,469,707	$66,525,475
Amount of dividends and interest	$46,142,902	$46,142,902	.....
Average rate of dividends and interest, per cent	3.44	3.62	.....

[1] Exclusive of 37 companies (21 operating electric railways with capitalization included in report for street and electric railways; 9 duplications due to corporations reporting capitalization in one state and owning establishments in another state, which are reported separately in certain of the tables; and 7 not reporting capitalization for sundry reasons), but including 2 companies reporting bonds only, their capital stock not being separable from other interests.

The capitalization reported for the 1,496 companies paying either dividends on stock or interest on funded debt is the total capitalization of these companies, and it includes capitalization upon which no return was made. For example, some companies paid interest on

Digitized by Google

bonds, but did not pay dividends on either preferred or common stock, and other companies paid dividends on preferred stock, but not on their common stock. The total outstanding stock and bonds of both classes of companies is included in this table. In Tables 62 to 65, inclusive, the analysis is extended to the dividend-paying stocks, common and preferred, and to the funded debt.

It is to be noted that the amount of stocks or bonds reported as outstanding is the amount outstanding at the close of the year covered by the report, and includes in many cases stocks or bonds issued during the year, while on the other hand it does not include any bonds which may have been retired during the year and on which interest was paid. The average rate of return in the shape of dividends or interest has necessarily to be computed on the basis of the amount of stocks or bonds reported as outstanding and on a twelve-month basis; hence, to the extent that dividends or interest were paid on stock or bonds issued during the year and therefore not for a full year, and also to the extent that interest was paid on bonds retired during the year, the average rates per cent are affected, but this element of error is believed to be so small as not to affect the results appreciably.

The number of companies paying dividends on either or both classes of stock constituted 28.7 per cent of the total number, and the outstanding stock of these companies constituted 55.7 per cent of the total amount of stock outstanding. This of course includes the common stock of companies paying dividends on preferred stock only as well as the common stock upon which dividends were paid.

Comparing Table 60 with Table 62 it will be seen that there were 61 companies paying dividends on preferred stock but not on common stock, these companies having $46,755,484 of common stock outstanding. From Table 129, which gives a detailed summary by states, the average dividend rate for all common stock in the several states may be deduced. Of the states reported separately, Massachusetts has the highest average dividend rate on common stock, 8.23 per cent, followed by Rhode Island, with 5.41 per cent; Connecticut, with 4.9 per cent; and New Hampshire, with 4.81 per cent. In 1902, of the states reported separately, Massachusetts, Rhode Island, Connecticut, and West Virginia were the leading states in respect to the average rate of dividends on common stock, with 7.26, 5.6, 4.77, and 4.61 per cent, respectively. In 1907, 18 states showed an average dividend of less than 1 per cent on the total outstanding common stock, or no returns at all on this class of stock, as compared with 21 states in 1902.

TABLE 62.—*Capital stock—Amount and dividends for companies paying dividends either on common or preferred stock, and amount for companies not paying dividends: 1907.*

	COMPANIES REPORTING CAPITALIZATION.		
	Total.	Companies paying dividends on either common or preferred stock.	Companies paying dividends on neither common nor preferred stock.
Number of companies	2,514	722	1,792
Capital stock:			
Amount outstanding, par value	$741,317,497	$413,089,622	$328,227,875
Amount of dividends	$19,300,572	$19,300,572	.....
Average rate of dividends, per cent.	2.60	4.67	.....

A distribution or classification of the common stock of the companies paying dividends on common stock, according to rates of dividends, is of interest as showing the prevailing rate or rates. Such a classification is given in Table 63.

TABLE 63.—COMMON STOCK—AMOUNT AND DIVIDENDS FOR COMPANIES PAYING DIVIDENDS, GROUPED BY RATE OF DIVIDENDS, AND AMOUNT FOR COMPANIES NOT PAYING DIVIDENDS: 1907.

	Number of companies.	COMMON STOCK, PAR VALUE.						
		Authorized.		Outstanding.		Dividends.		
		Amount.	Per cent distribution.	Amount.	Per cent distribution.	Amount.	Per cent distribution.	Average rate, per cent.
Companies reporting common stock	2,514	$798,873,386	100.0	$666,003,772	100.0	$16,883,812	100.0	2.54
Companies paying dividends on common stock	661	378,019,099	47.3	321,509,301	48.3	16,883,812	100.0	5.25
Rate of dividends:								
Less than 1 per cent	2	3,750,000	0.5	3,582,500	0.5	17,010	0.1	0.47
1 per cent but less than 2	16	14,235,000	1.8	14,101,400	2.1	171,290	1.0	1.21
2 per cent but less than 3	35	12,582,500	1.6	11,568,800	1.7	253,620	1.5	2.19
3 per cent but less than 4	48	38,372,000	4.8	24,816,630	3.7	731,059	4.3	2.95
4 per cent but less than 5	46	10,277,366	1.3	9,174,666	1.4	366,986	2.2	4.00
5 per cent but less than 6	98	96,341,950	12.1	75,694,700	11.4	2,846,735	16.9	3.76
6 per cent but less than 7	141	76,540,983	9.6	69,950,195	10.5	4,101,328	24.3	5.86
7 per cent but less than 8	26	60,942,300	7.6	55,310,185	8.3	2,853,152	16.9	5.16
8 per cent but less than 9	67	30,052,600	3.8	25,412,100	3.8	1,954,800	11.6	7.69
9 per cent but less than 10	7	1,060,000	0.1	1,026,575	0.2	92,415	0.5	9.00
10 per cent and over	175	33,864,400	4.2	30,871,550	4.6	3,495,417	20.7	11.32
Companies not paying dividends on common stock	1,853	420,854,287	52.7	344,494,471	51.7	.....	.....	.....

The companies paying dividends on common stock formed 26.3 per cent of the total number, and the outstanding common stock of these companies formed 48.3 per cent of the total amount outstanding; that

Digitized by Google

is, nearly three-fourths of the companies paid no dividends at all upon their common stock, and no dividends were paid on more than one-half of the common stock outstanding.

The rate of dividends indicated for each group frequently is not paid on the entire amount of outstanding stock credited to the group. The stock reported as outstanding is the amount outstanding at the close of the year and includes any stock which may have been issued during the year, even near its close, and on which dividends were not paid, and also the total outstanding common stock of companies, although dividends were paid on a portion only of their common stock. The rates reported are such as were given in the schedules, except in a few cases where the amount of the dividend was reported and the rate omitted, in which case the rate was established in the office by its relation to the outstanding stock. It must be understood, therefore, that the rate refers only to the amount of stock on which the dividends were declared, but the amount of this dividend stock was not reported. For these reasons, in several of the rate groups, the average rate computed from the amount of common stock outstanding and the amount paid in dividends on common stock falls short of the group rate.

A noticeable feature of this table is the relatively large number of companies paying dividends of 10 per cent or over, these companies constituting 26.5 per cent of the companies paying dividends on common stock. Next to this group the largest number of companies paying dividends on common stock is shown for the group with a rate of 6 per cent but less than 7, which also shows the largest amount disbursed as dividends on common stock of any group.

The preferred stock on which dividends were paid, distributed by rate groups, is shown in Table 64.

TABLE 64.—PREFERRED STOCK—AMOUNT AND DIVIDENDS FOR COMPANIES PAYING DIVIDENDS, GROUPED BY RATE OF DIVIDENDS, AND AMOUNT FOR COMPANIES NOT PAYING DIVIDENDS: 1907.

	Number of companies.	PREFERRED STOCK, PAR VALUE.						
		Authorized.		Outstanding.		Dividends.		
		Amount.	Per cent distribution.	Amount.	Per cent distribution.	Amount.	Per cent distribution.	Average rate, per cent.
Companies reporting preferred stock	183	$101,218,774	100.0	$75,313,725	100.0	$2,416,760	100.0	3.21
Companies paying dividends on preferred stock	101	61,664,274	60.9	44,824,837	59.5	2,416,760	100.0	5.39
Rate of dividends:								
1 per cent but less than 2	1	200,000	0.2	110,833	0.1	1,663	0.1	1.50
2 per cent but less than 3	2	1,044,000	1.0	244,000	0.3	5,880	0.2	2.41
3 per cent but less than 4	6	368,900	0.4	368,900	0.5	11,067	0.5	3.00
4 per cent but less than 5								
5 per cent but less than 6	27	24,280,500	24.0	19,418,600	25.8	938,379	38.8	4.83
6 per cent but less than 7	50	34,474,674	34.1	23,432,304	31.1	1,369,845	56.7	5.85
7 per cent but less than 8	10	1,013,700	1.0	967,700	1.3	67,739	2.8	7.00
8 per cent and over	5	282,500	0.3	282,500	0.4	22,187	0 9	7.85
Companies not paying dividends on preferred stock	82	39,554,500	39.1	30,488,888	40.5			

The companies paying dividends on preferred stock formed 55.2 per cent of the total number having preferred stock, and the preferred stock of these companies constituted 59.5 per cent of the total amount of preferred stock outstanding. Of the companies paying dividends, those reporting a rate of 6 per cent but less than 7 are most numerous and reported the major portion of the dividends paid on preferred stock.

Table 65 shows the number of companies reporting funded debt at the census of 1907, the amount of debt, both authorized and outstanding, and the amount of interest paid. It also distinguishes between the companies that did and did not pay interest.

The amount shown as interest on funded debt is not the total interest chargeable for the year on the total outstanding debt. It is common practice to charge all or a part of the interest to the plant account while construction is going on, and hence in such cases the total amount of interest on funded debt does not appear in the income account from which the census figures of interest on funded debt are taken, but only that portion of it which is charged against income. There were other conditions also which operated in certain cases to prevent the showing of interest on funded debt in the statistics, such as the use of bonds as collateral for floating debt and the waiver of the payment of interest by special agreement, not to mention the defaulting of interest. There were 51 companies with funded debt outstanding which for various reasons did not show any interest charge in the income account. The companies reporting funded debt formed 44.9 per cent of the total number, and interest was paid upon all but 1.5 per cent of the total amount outstanding.

TABLE 65.—*Funded debt—Amount and interest for companies paying interest and amount for companies not paying interest: 1907.*

	COMPANIES REPORTING FUNDED DEBT.		
	All companies.	Companies paying interest.	Companies not paying interest.
Number of companies	1,129	1,078	51
Funded debt:			
Amount authorized	$815,516,672	$788,113,672	$27,403,000
Amount outstanding	$600,677,685	$591,406,885	$9,270,800
Amount of interest	$26,842,330	$26,842,330	
Average rate of interest, per cent	4.47	4.54	

Digitized by Google

In Table 66 the companies having funded debt are classified according to the rate of interest on their bonds. In cases where companies had bond issues bearing different rates of interest, they are classified according to the average rate paid on the whole debt.

TABLE 66.—*Companies reporting funded debt, grouped by rate of interest: 1907.*

	COMPANIES REPORTING FUNDED DEBT.	
	Number.	Per cent distribution.
Companies reporting funded debt	1,129	100.0
Companies paying interest on funded debt	1,078	95.5
Rate of interest:		
Less than 4 per cent	11	1.0
4 per cent but less than 5	63	5.8
5 per cent but less than 6	638	59.2
6 per cent but less than 7	334	31.0
7 per cent but less than 8	23	2.1
8 per cent and over	9	0.8
Companies not paying interest on funded debt	51	4.5

Capitalization statistics of companies, classified according to dynamo capacity.—A large majority of the companies organized since 1902 are comparatively small, and while some large companies have been organized to construct new plants, most of them have been formed by the reorganization and consolidation of companies that were in existence in 1902. These reorganizations are made for the avowed purpose of effecting economies that are not possible in the small companies. This being the case, it would be expected that the larger companies would secure greater profit on the year's business, which in turn would be reflected in a larger rate of dividends on the capital stock. While the census classification of companies according to size on the basis of dynamo capacity is not a perfect classification for the purpose indicated, it is of interest, and the statistics are presented in Table 67.

Of the total number of companies in 1907, 162, or 6.4 per cent, purchased current and hence form a class by themselves. The capitalization of these companies represented 5.5 per cent of the total capitalization, and averaged $456,017 per company, compared with an average of $538,709 per company for the 2,354 companies equipped with dynamos and generating current.

TABLE 67.—CAPITALIZATION STATISTICS OF COMMERCIAL COMPANIES, CLASSIFIED ACCORDING TO DYNAMO CAPACITY OF STATIONS: 1907.

DYNAMO CAPACITY OF STATIONS IN KILOWATTS.	CAPITALIZATION.				CAPITAL STOCK.			
			Dividends and interest.		Total.			
	Number of companies reporting.	Amount.	Amount.	Average rate, per cent.	Number of companies reporting.	Amount.	Dividends.	
							Amount.	Average rate, per cent.
Total	[1] 2,516	$1,341,995,182	$46,142,902	3.44	2,514	$741,317,497	$19,300,572	2.60
Under 200	1,281	50,680,027	1,258,055	2.48	1,279	39,710,805	719,929	1.81
200 but under 500	534	64,807,465	1,509,489	2.33	534	42,440,338	506,033	1.19
500 but under 1,000	207	60,606,542	1,881,907	3.11	207	35,003,975	604,544	1.73
1,000 but under 2,000	150	129,337,257	3,866,422	2.99	150	78,524,091	1,447,998	1.84
2,000 but under 5,000	109	210,387,010	7,069,033	3.36	109	122,263,210	3,263,396	2.67
5,000 and over	73	752,302,191	27,818,119	3.70	73	384,844,788	11,658,581	3.03
Companies without generating equipment	162	73,874,690	2,739,877	3.71	162	38,530,290	1,100,091	2.86

DYNAMO CAPACITY OF STATIONS IN KILOWATTS.	CAPITAL STOCK—continued.								FUNDED DEBT.			
	Common.				Preferred.						Interest.	
	Number of companies reporting.	Amount.	Dividends.		Number of companies reporting.	Amount.	Dividends.		Number of companies reporting.	Amount.	Amount.	Average rate, per cent.
			Amount.	Average rate, per cent.			Amount.	Average rate, per cent.				
Total	2,514	$666,003,772	$16,883,812	2.54	183	$75,313,725	$2,416,760	3.21	1,129	$600,677,685	$26,842,330	4.47
Under 200	1,279	38,757,905	694,358	1.79	43	952,900	25,571	2.68	374	10,969,222	538,126	4.91
200 but under 500	534	40,169,155	470,434	1.17	35	2,271,183	35,599	1.57	290	22,367,127	1,003,456	4.49
500 but under 1,000	207	32,571,675	538,129	1.65	25	2,432,300	66,415	2.73	148	25,602,567	1,277,363	4.99
1,000 but under 2,000	150	71,831,091	1,224,350	1.70	28	6,693,000	223,648	3.34	116	50,813,166	2,418,424	4.76
2,000 but under 5,000	109	112,158,110	3,037,456	2.71	21	10,105,100	225,940	2.24	86	88,123,800	3,805,637	4.32
5,000 and over	73	336,915,946	9,961,494	2.96	26	47,928,842	1,697,087	3.54	68	367,457,403	16,159,538	4.40
Companies without generating equipment	162	33,599,890	957,591	2.85	5	4,930,400	142,500	2.89	47	35,344,400	1,639,786	4.64

[1] Including 2 companies reporting bonds only, their capital stock not being separable from other interests.

Digitized by Google

The group of small companies, those operating stations with a dynamo capacity of less than 200 kilowatts, constituted 50.9 per cent of the total number, but their capitalization formed but 3.8 per cent of the total capitalization and averaged but $39,563 per company. On the other hand, the companies operating stations with a capacity of 5,000 kilowatts or over constituted only 2.9 per cent of the total number, but represented 56.1 per cent of the total capitalization, with an average of $10,305,509 per company. It should be remembered that the amounts of common stock, preferred stock, and funded debt shown for the several groups are the total amounts outstanding and include nondividend-paying stocks and noninterest-paying bonds as well as those upon which dividends or interest was paid. For this reason, the average rates per cent, as given, do not represent the average rates per cent for stocks upon which dividends were paid or for funded debt upon which interest was paid, but the average return in the form of dividends or interest on the total amounts of stock or funded debt outstanding, respectively. In most cases the average rate of return is better for companies operating stations with a high dynamo capacity than for those operating stations with a low capacity, though the rule does not hold in all cases.

Table 68 shows the per cent distribution of the number of companies reporting, capitalization, and dividends and interest for the several groups, and the average capitalization per company for each group.

TABLE 68.—*Per cent distribution, by dynamo capacity, of number of companies, capitalization, and dividends and interest, and average capitalization per company: 1907.*

KILOWATT CAPACITY OF DYNAMOS.	PER CENT DISTRIBUTION.			Average capitalization per company.
	All companies.	Capitalization.	Dividends and interest.	
Total	100.0	100.0	100.0	$533,384
Under 200	50.9	3.8	2.7	39,563
200 but under 500	21.2	4.8	3.3	121,362
500 but under 1,000	8.2	4.5	4.1	292,785
1,000 but under 2,000	6.0	9.6	8.4	862,248
2,000 but under 5,000	4.3	15.7	15.3	1,930,156
5,000 and over	2.9	56.1	60.3	10,305,509
Companies without generating equipment	6.4	5.5	5.9	456,017

The analysis of the statistics might be carried to the point of ascertaining the earnings of the incorporated companies, classified according to dynamo capacity and the relation the earnings bear to the capitalization for the several groups. But any deductions in regard to earnings that might be drawn from these returns are apt to be misleading.[1] The amounts disbursed in the form of interest and dividends by the different groups of companies can be used, however, in lieu of earnings, as a basis of comparison, and these disbursements for groups of companies will give results which will approximate comparisons of earnings. Hence the fact that the average rate per cent of dividends and interest combined, as well as the average rate per cent of dividends on common stock, as given in Table 67, shows a general tendency to increase with dynamo capacity, can be taken as an indication of the relative increase in the rate of earnings accompanying increase in capitalization. It will be noted also in this connection that the rate of interest on funded debt shows no such increase, but in fact is smaller for the highest group than for the lowest.

As a general rule, increase in capitalization is accompanied by an increase in the proportion of the capitalization represented by both preferred stock and funded debt, with a decrease in the proportion of the capitalization represented by common stock—that is, the larger the capitalization the larger the percentage thereof represented by preferred stock and by funded debt, and the smaller the percentage represented by common stock. Although the application of this rule to individual companies or to small groups of companies would show exceptions, yet it holds good when the companies are grouped on lines broad enough to eliminate minor variations, as shown by the following tabular statement:

Average capitalization per company and per cent distribution of capitalization for groups of companies, classified according to dynamo capacity: 1907.

	All companies.	COMPANIES WITH A DYNAMO CAPACITY OF—			
		Under 200 kilowatts.	200 but under 1,000 kilowatts.	1,000 but under 5,000 kilowatts.	5,000 kilowatts and over.
Average capitalization per company	$538,709	$39,563	$169,250	$1,311,677	$10,305,509
Per cent distribution: Capitalization	100.0	100.0	100.0	100.0	100.0
Capital stock	55.4	78.4	61.8	59.1	51.2
Common stock	49.9	76.5	58.0	54.2	44.8
Preferred stock	5.5	1.9	3.8	4.9	6.4
Funded debt	44.6	21.6	38.2	40.9	48.8

The above statement is confined to the companies having generating equipment. It will be seen that the percentage which common stock forms of the total capitalization decreases uninterruptedly from 76.5 per cent for the lowest group, companies operating stations with a capacity of less than 200 kilowatts, to 44.8 per cent for the highest group, companies operating stations with a capacity of 5,000 kilowatts and over; while the percentage for preferred stock increases uninterruptedly from 1.9 per cent to 6.4 per cent for the successive groups, and the percentage for funded debt from 21.6 per cent to 48.8 per cent.

[1] See p. 87, Ch. VII.

Digitized by Google

Municipal stations.—The increase in the number of municipal stations is naturally accompanied by an increase in the municipal bonds issued on account of these stations.

TABLE 69.—*Municipal stations—Funded debt and interest: 1907 and 1902.*

	1907	1902	Per cent of increase.
Number of stations	1,252	815	53.6
Reporting bonds outstanding	998	656	52.1
Reporting no bonds outstanding	254	159	59.7
Funded debt:			
Amount authorized	$29,031,638	$12,625,482	129.9
Amount outstanding	$25,343,654	$11,609,488	118.3
Amount of interest	$1,149,432	$504,805	127.7
Average rate of interest, per cent	4.54	4.35	.....

As a general rule, the rate of interest on the bonds of municipalities is lower than on those of private enterprises, and in 1902 the average rate on municipal bonds issued against light and power stations was 4.35 per cent, compared with a corresponding rate of 4.76 per cent for incorporated commercial companies. But the bond rate for commercial companies shows a lower average in 1907 than in 1902, while a slight increase is shown in the rate for municipal bonds, so that, as before noted, the average rate of interest on the net amount of funded debt of the commercial companies upon which interest was paid in 1907 was the same as that for municipal bonds, 4.54 per cent.

The municipal stations reporting bonds outstanding in 1907 represented 79.7 per cent of the total number compared with 80.5 per cent in 1902, and the outstanding bonds represented 87.3 per cent of the amount authorized in 1907 compared with 92 per cent in 1902. The average amount of bonded indebtedness per station has increased materially, being $25,394 per station in 1907 compared with $17,697 in 1902.

The bonded debt of the composite municipal stations formed 57.4 per cent of the total for municipal stations, and the average rate of interest was 4.8 per cent, compared with an average rate of 4.18 per cent for the purely electric municipal stations.

TABLE 70.—*Municipal stations—Funded debt and interest for purely electric and composite stations: 1907.*

	MUNICIPAL STATIONS.				
	Total number.	Purely electric.	Composite.	Per cent of total.	
				Purely electric.	Composite.
Number of stations	1,252	521	731	41.6	58.4
Number reporting bonds outstanding	998	410	588	41.1	58.9
Funded debt:					
Amount outstanding	$25,343,654	$10,799,693	$14,543,961	42.6	57.4
Amount of interest	$1,149,432	$451,776	$697,656	39.3	60.7
Average rate of interest, per cent	4.54	4.18	4.80	.....	.....

In making the reports for municipal stations carrying on business of a composite character, an estimate was given of the proportionate part of the bonded investments chargeable to the electric light and power industry, as was done with respect to capital investments in the case of the commercial companies, and although these estimates are in most cases only approximations and do not represent book values, yet they afford a basis for arriving at a general estimate of the amount of municipal bonds and interest paid thereon represented by the electric light and power industry. Table 71 accordingly shows the estimated amount of bonds chargeable to the electric light and power industry and to the allied industries, respectively.

TABLE 71.—*Municipal stations—Distribution of funded debt and interest between the electric light and power industry and allied industries: 1907.*

	BONDS OUTSTANDING.		INTEREST.	
	Amount.	Per cent distribution.	Amount.	Average rate, per cent.
Total	$25,343,654	100.0	$1,149,432	4.54
Electric light and power industry	20,479,798	80.8	911,190	4.45
Purely electric stations	10,697,093	42.2	446,883	4.18
Composite stations	9,782,705	38.6	464,307	4.75
Allied industries	[1]4,863,856	19.2	238,242	4.90

[1] Includes $102,600 reported for companies classified as purely electric, upon which interest amounting to $4,893 was paid.

Digitized by Google

CHAPTER VI.

COST OF CONSTRUCTION AND EQUIPMENT.

General discussion.—The schedule used in the census of 1902 called for a separate statement as to the cost of land; buildings; machinery, tools, and implements within stations; overhead electric-service construction; underground electric-service construction; lamps, motors, meters, and transformers, wired for use; supplies of every description on hand; and miscellaneous equipment. The object of these inquiries was to ascertain the total cost of the plant and equipment, as represented by the total amount expended for the original construction and for all subsequent extensions, additions, and repairs to the same. It was presumed that the electric companies kept an account of this kind, but a majority contended that it was impossible to report the cost in such detail, and many asserted that they had no data from which even the total cost of the plant and equipment to date could be estimated with a fair degree of accuracy. Moreover, a considerable number of the electric stations have changed ownership during recent years, and the purchase price often has little relation to the actual cost of the plant, and in fact seldom, if ever, represents this cost. The transfer is frequently made through the exchange of stock or by some other arrangement, whereby it is impossible to ascertain the money equivalent. In view of these conditions, the attempt to ascertain the cost of construction in such detail was abandoned in 1907, but in an effort to preserve the comparative value of the statistics, the total cost of the plant and equipment to date and the cost of construction during the census year were requested.

TABLE 72.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—TOTAL COST OF PLANTS AND EQUIPMENT; AVERAGE COST PER KILOWATT CAPACITY OF DYNAMOS AND PER HORSEPOWER CAPACITY OF ENGINES AND WATER WHEELS; AND COST OF CONSTRUCTION DURING THE CENSUS YEAR: 1907 AND 1902.

	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total cost of plants and equipment	$1,096,913,622	$504,740,352	$1,054,034,175	$482,719,879	$42,879,447	$22,020,473
Total kilowatt capacity of dynamos	2,709,225	1,212,235	2,500,209	1,098,855	209,016	113,380
Average cost per kilowatt capacity of dynamos	$405	$416	$422	$439	$205	$194
Total horsepower capacity of engines and water wheels	4,098,188	1,845,048	3,776,837	1,685,020	321,351	160,028
Average cost per horsepower capacity of engines and water wheels	$268	$274	$279	$286	$133	$138
Cost of construction during the census year	$100,912,573	$41,792,447	$95,746,208	$40,050,613	$5,166,365	$1,741,834

The total cost of all central stations up to the end of the census year 1907 as compared with that similarly reported for 1902 showed an increase of $592,173,270, or 117.3 per cent. In the same period the total cost reported for the commercial stations, which in 1907 represented 96.1 per cent of the total cost of all stations, and in 1902, 95.6 per cent, increased 118.4 per cent. The corresponding increase for the municipal stations was 94.7 per cent. The average cost of plant and equipment reported for all stations in 1907 was $232,693; for commercial stations, $304,458; and for municipal stations, $34,249. In 1902 the corresponding averages were $139,431, $172,093, and $27,019, respectively.

Many and varying factors enter into the cost of plants and equipment. Sites and rights, which in one instance may cost but little, in another may be very expensive. The installation and equipment of a station designed and prepared to supply current to a large city or thickly settled community, is quite unlike that of a station transmitting electricity considerable distances and selling in bulk to but few customers. These conflicting elements are encountered in any attempt to arrive at an average cost per station or per kilowatt capacity of dynamo. In endeavoring to arrive at an average cost per dynamo capacity there is always the uncertainty as to the extent of the installation of surplus dynamos, which frequently do not, in a true sense, represent the capacity of the plant, but merely a reserve to be brought into use in case of a breakdown, need for repairs, etc. The decrease in the average cost per horsepower in both commercial and municipal stations and in average cost per kilowatt capacity of dynamos for commercial stations, may be influenced by the fact that in anticipation of future demands upon them, plants have in recent years been constructed with a more general excess of both primary power and dynamo capacity.

In but 1 state, Utah, was the total cost of plants and equipment reported less in 1907 than in 1902, and

Digitized by Google

in this instance the decrease was due to the fact that one of the largest of the central stations in the state for which statistics were secured in 1902 has since that date been combined with an electric railway, so that in 1907 it was included with the latter branch of the industry.

There were 7 states each of which reported in 1907 a total cost of plants and equipment of more than $40,000,000. These states, together with the amounts thus reported and the corresponding totals for 1902, are shown in Table 73.

TABLE 73.—*Total cost of plants and equipment for states each of which in 1907 reported a total of more than $40,000,000: 1907 and 1902.*

STATE.	TOTAL COST OF PLANTS AND EQUIPMENT.	
	1907	1902
Total for United States	$1,096,913,622	$504,740,352
Total for 7 selected states	677,617,993	341,831,031
New York	252,731,789	112,998,778
California	111,780,551	36,547,474
Illinois	88,142,233	38,329,275
Pennsylvania	73,907,749	41,579,338
New Jersey	65,219,445	56,432,502
Massachusetts	43,279,226	29,562,267
Ohio	42,557,000	26,381,397

At both censuses the totals for these 7 states formed approximately the same proportion of the corresponding totals for the entire United States, somewhat less than two-thirds in 1907 and slightly more than two-thirds in 1902.

Some of the most notable increases in the state totals in the cost of construction are shown in Table 74.

TABLE 74.—*Notable increases in the total cost of construction for 20 selected states in 1907 over the amount reported in 1902.*

STATE.	TOTAL COST OF PLANTS AND EQUIPMENT.		Actual increase.	Per cent of increase.
	1907	1902		
Total for United States	$1,096,913,622	$504,740,352	$592,173,270	117.3
Total for 20 selected states	853,914,225	358,809,493	495,104,732	138.0
Alabama	7,293,876	908,895	6,384,981	702.5
California	111,780,551	36,547,474	75,233,077	205.9
Colorado	23,126,179	8,665,826	14,460,353	166.9
Georgia	7,354,286	1,252,578	6,101,708	487.1
Illinois	88,142,233	38,329,275	49,812,958	130.0
Indiana	25,680,710	6,706,510	18,974,200	282.9
Maryland	21,274,959	7,157,986	14,116,973	197.2
Massachusetts	43,279,226	29,562,267	13,716,959	46.4
Michigan	37,001,060	11,559,169	25,441,891	220.1
Minnesota	24,138,081	9,236,505	14,901,576	161.3
Missouri	33,865,760	15,679,872	18,185,888	116.0
Montana	17,950,677	4,740,807	13,209,870	278.6
Nevada	4,299,631	301,785	3,997,846	1,324.7
New York	252,731,789	112,998,778	139,733,011	123.7
Ohio	42,557,000	26,381,397	16,175,603	61.3
Oklahoma	7,130,864	597,516	6,533,348	1,093.4
Pennsylvania	73,907,749	41,579,338	32,328,411	77.8
South Carolina	8,803,382	2,442,989	6,360,393	260.4
South Dakota	2,806,363	623,504	2,182,859	350.1
Washington	20,789,849	3,537,022	17,252,827	487.8

The total cost of construction for these 20 states formed more than three-fourths of the total for the United States in 1907 and only a little less than three-fourths in 1902; the corresponding amount of increase for these states was nearly seven-eighths of the total increase for the country.

For reasons already stated, the cost of the plants as reported to the Census Bureau does not represent the actual cost of installing a central station nor indicate the actual relative costs of stations equipped with water power as compared with those equipped with steam power. The reported cost does, however, give an approximate idea of the cost of construction, and the classification of the total cost reported according to the primary power used in the stations gives additional indication of the relative importance of the different classes of power. This classification is made in Tables 75 and 76.

In comparing the statistics for the different kinds of primary power for 1902 with those for 1907, it should be remembered that stations which in 1902 were operated by either steam or water power might, because of the extension of the service, or for other reasons, find the original power inadequate and by the addition of power of another character, be thrown into a different group in 1907. The extent of these changes is, however, a matter of great uncertainty.

The stations using steam exclusively as primary power in 1907 reported 57.7 per cent of the total cost of plants and equipment for all central stations, and if to this is added the cost of the stations which are practically steam plants but have minor power of some other kind, the proportion reported by stations using steam would be 64.4 per cent. But even this large percentage does not fully represent the cost of the steam equipment, since there is also a large amount represented by the plants in the class using water and steam. The remainder, with the exception of about one-half of 1 per cent of the total cost contributed by the plants equipped with gas as the primary power, represents the cost of plants using water power, or without primary-power equipment. In 1907 the plants using water exclusively reported 11.6 per cent of the total cost, and those equipped with water with other minor power, 2.8 per cent. Thus 14.4 per cent of the total cost was represented by this kind of power, exclusive of the portion represented by stations in the group "water and steam."

In 1907 the North Central states had about three-sevenths of the total number of stations, but the cost of plants and equipment reported for that division was only a little more than one-fourth of the total for all central stations; the North Atlantic division, on the other hand, with about one-half as many stations, reported somewhat less than twice the amount for cost of plants and equipment. The Western division was third, with a little less than one-fifth of the total cost, while the South Atlantic and South Central divisions each reported about one-twentieth.

Digitized by Google

TABLE 75.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—TOTAL COST OF PLANTS AND EQUIPMENT, BY KIND OF PRIMARY POWER: 1907 AND 1902.

KIND OF POWER.	Census.	TOTAL.		COMMERCIAL.		MUNICIPAL.	
		Number of stations.	Cost of plants and equipment.	Number of stations.	Cost of plants and equipment.	Number of stations.	Cost of plants and equipment.
Total	1907	4,714	$1,096,913,622	3,462	$1,054,034,175	1,252	$42,879,447
	1902	3,620	504,740,352	2,805	482,719,879	815	22,020,473
Steam exclusively	1907	3,262	633,050,959	2,199	598,742,435	1,063	34,308,524
	1902	2,747	325,912,662	2,008	306,232,439	739	19,680,223
Steam with other minor power	1907	93	73,016,313	80	72,260,226	13	756,087
	1902	43	48,904,865	41	48,831,365	2	73,500
Water exclusively	1907	474	127,722,346	413	124,318,422	61	3,403,924
	1902	315	38,387,077	281	37,319,076	34	1,068,001
Water with other minor power	1907	61	30,900,788	59	30,836,527	2	64,261
	1902	20	14,879,731	19	14,854,719	1	25,012
Water and steam	1907	360	176,837,370	337	174,697,251	23	2,140,119
	1902	275	65,670,174	266	65,179,991	9	490,183
Gas exclusively	1907	180	4,634,303	137	4,040,379	43	593,924
	1902	51	2,600,377	38	2,499,534	13	100,843
Stations without primary-power equipment	1907	284	50,751,543	237	49,138,935	47	1,612,608
	1902	169	8,385,466	152	7,802,755	17	582,711

TABLE 76.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—COST OF PLANTS AND EQUIPMENT, BY KIND OF PRIMARY POWER USED AND BY GEOGRAPHIC DIVISIONS: 1907 AND 1902.

DIVISION.	Census.	Number of stations.	Total.	Steam exclusively.	Steam with other minor power.	Water exclusively.	Water with other minor power.	Water and steam.	Gas exclusively.	Stations without primary-power equipment.
United States	1907	4,714	$1,096,913,622	$633,050,959	$73,016,313	$127,722,346	$30,900,788	$176,837,370	$4,634,303	$50,751,543
	1902	3,620	504,740,352	325,912,662	48,904,865	38,387,077	14,879,731	65,670,174	2,600,377	8,385,466
North Atlantic	1907	1,070	484,441,333	287,302,016	61,814,755	52,219,507	3,331,165	45,882,261	2,712,242	31,179,387
	1902	913	266,548,738	161,398,717	42,101,267	6,975,986	13,752,012	36,565,192	2,144,121	3,611,443
South Atlantic	1907	390	58,513,594	40,779,550	370,000	7,472,369	4,787,410	4,464,121	69,578	570,566
	1902	251	19,462,480	16,406,853	.....	2,041,027	597,972	207,100	51,800	157,728
North Central	1907	2,095	290,238,111	211,879,482	9,657,530	17,606,655	9,670,351	31,790,294	1,237,379	8,396,420
	1902	1,706	127,495,351	109,632,429	1,275,982	3,744,421	108,077	11,786,737	324,667	623,038
South Central	1907	679	59,366,131	53,947,895	837,028	325,905	.....	3,381,268	435,645	438,390
	1902	404	22,328,727	21,885,209	15,190	234,551	.....	109,510	23,414	60,853
Western	1907	480	204,354,453	39,142,016	337,000	50,097,910	13,111,862	91,319,426	179,459	10,166,780
	1902	346	68,905,056	16,589,454	5,512,426	25,391,092	421,670	17,001,635	56,375	3,932,404

The cost of plants having steam as the primary power developed most rapidly in the North Atlantic and North Central divisions and least rapidly in the Western division. Measured by the cost of construction, the North Atlantic, Western, and North Central divisions represented the highest development of water power, as did the North Atlantic of stations equipped with gas as the primary power.

The remarkable increase in the cost of plants and equipment reported for stations which are not equipped with primary power was altogether disproportionate to the increase in their number. The use of water power and the ability to deliver the electric energy at long distances from the generating plant, and at a low cost, have brought about a great change in the installation of power machines and dynamos in central electric stations. New stations have been built without such equipment, sometimes not only purchasing the current but selling the same in bulk to other stations by means of long-transmission lines. Many stations originally equipped with generating apparatus have had such apparatus removed because it has been found to be more economical to purchase current than to generate it. The largest increases for stations not equipped with primary power were in the North Atlantic, North Central, and Western divisions.

In 1902 the cost of construction by character of ownership was not reported, hence comparative figures are not available. These figures, however, are shown for 1907 in Table 77.

Digitized by Google

TABLE 77.—*Total cost of plants and equipment, by character of ownership: 1907.*

CHARACTER OF OWNERSHIP.	Total cost of plants and equipment.	Per cent distribution.
Total	$1,096,913,622	100.0
Individual	6,574,920	0.6
Firm	4,019,813	0.4
Incorporated company[1]	1,043,439,442	95.1
Municipal	42,879,447	3.9

[1] Includes 2 establishments classed under the head "All other forms of ownership," in order that the operations of individual establishments may not be disclosed.

This table shows the importance of corporate ownership and the comparative insignificance of all the other forms of ownership so far as they relate to the cost of electric stations. The total cost of construction for the municipal stations was slightly less than 4 per cent of the total, while that for individuals and firms combined was but 1 per cent.

During the census year 1907, $100,912,573 was expended for new stations and for additions and extensions to those already in existence. This amount represented an increase of $59,120,126, or 141.5 per cent, over the amount reported as similarly expended during 1902. For the commercial stations the increase amounted to $55,695,595, or 139.1 per cent, and for the municipal stations to $3,424,531, or 196.6 per cent. The total cost of new construction reported for 1907, classified by kind of primary power used in the respective stations, is shown by geographic divisions in Table 78.

TABLE 78.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—COST OF CONSTRUCTION DURING THE YEAR, BY KIND OF PRIMARY POWER USED AND BY GEOGRAPHIC DIVISIONS: 1907.

DIVISION.	Number of stations.	Total.	Steam exclusively.	Steam with other minor power.	Water exclusively.	Water with other minor power.	Water and steam.	Gas exclusively.	Stations without primary-power equipment.
United States	4,714	$100,912,573	$54,505,377	$4,413,308	$8,715,446	$3,532,877	$13,776,002	$643,331	$15,326,232
North Atlantic	1,070	41,989,031	20,462,608	3,613,408	1,872,932	122,145	4,060,573	233,018	11,624,347
South Atlantic	390	7,023,710	5,014,384	30,855	496,615	1,287,936	126,857	2,281	64,782
North Central	2,095	28,091,301	19,652,627	610,849	1,999,692	1,392,634	2,753,211	207,627	1,474,661
South Central	679	5,216,238	4,784,711	133,196	20,953	.....	108,725	145,961	22,692
Western	480	18,592,293	4,591,047	25,000	4,325,254	730,162	6,726,636	54,444	2,139,750

The cost of construction during the year was distributed among the several geographic divisions in much the same relative proportions as was the total cost of plants and equipment reported, and the same is true also of the expenditures reported during the year upon the stations in most of the different groups, by kind of power used. The Western division, however, for the stations using water exclusively shows a much larger proportion of the total cost of construction during the year for this kind of power than of the total cost of plants and equipment to date for the same kind of power, while the reverse is true for the stations of the Western division which use water as the primary power but have minor power of some other kind.

In 7 states and territories there was a decrease in the total cost of new construction during the census year in 1907 as compared with 1902, namely: Arizona, Iowa, Maine, Massachusetts, Nevada, New Hampshire, and Rhode Island. In each case the decline was due to decreased expenditures on the commercial plants. In 2 other states—Arkansas and Florida—decreases in the cost of new construction for the commercial plants were more than offset by increases in the amounts expended by municipal stations, so that the totals for the two branches of the industry showed increases.

In 3 states—Delaware, Kentucky, and West Virginia—a decrease was reported for municipal plants, although in each instance the amount was small.

The statistics for some of the states in which the largest amounts were expended by commercial stations on new construction during 1907 are shown in Table 79.

The figures for commercial stations show that the greatest expenditure in new construction during 1907 for plants using steam power occurred in the state of New York, Illinois ranking second in this respect. The greatest amounts for new construction in connection with plants using water power exclusively and for those using both water and steam power were expended in California.

Digitized by Google

TABLE 79.—COMMERCIAL CENTRAL ELECTRIC STATIONS—COST OF CONSTRUCTION DURING THE YEAR FOR SELECTED STATES, BY GEOGRAPHIC DIVISIONS AND KIND OF PRIMARY POWER: 1907.

	Total.	Steam exclusively.	Steam with other minor power.	Water exclusively.	Water with other minor power.	Water and steam.	Gas exclusively.	Stations without primary power equipment.
Total for commercial stations	$95,746,208	$50,540,907	$4,268,353	$8,261,987	$3,532,027	$13,566,719	$541,003	$15,035,212
Total for selected states	75,892,395	39,637,792	3,761,152	5,801,188	1,657,524	11,043,859	315,223	13,675,657
North Atlantic division:								
Massachusetts	4,613,916	3,975,826	90,369	19,194	776	469,416	296	58,039
New Jersey	3,834,018	504,827	3,297,519	4,980	7,075	3,025	900	15,692
New York	23,403,555	9,688,551	17,595	1,353,133	24,132	1,119,484	26,873	11,173,787
Pennsylvania	6,686,401	5,110,074	18,190	164,141	349	1,053,874	120,024	219,749
South Atlantic division:								
Maryland	2,914,439	2,871,656	21,969	500	4,476	8,838	.....	7,000
North Central division:								
Illinois	7,900,051	7,578,177	46,510	1,514	180,245	40,026	4,400	49,179
Michigan	3,761,219	1,103,413	59,844	193,070	1,146,159	997,270	20,500	240,963
Minnesota	2,632,701	264,729	12,044	1,549,551	.....	785,583	7,414	13,380
Ohio	3,572,162	3,475,463	47,892	.....	1,200	17,717	28,911	979
South Central division:								
Texas	1,616,022	1,362,268	129,220	.....	.....	39,723	84,361	450
Western division:								
California	8,849,652	1,876,787	20,000	1,914,801	1,200	4,851,493	.....	185,371
Colorado	2,005,800	1,582,290	.....	339,790	26,996	26,121	20,744	9,859
Oregon	1,657,903	129,265	.....	116,951	.....	1,389,400	800	21,487
Washington	2,444,556	114,466	.....	143,563	264,916	241,889	.....	1,679,722

There were 96 stations reported as under construction during the year 1907, which were not in actual operation before the close of the year. These stations properly form a part of the new construction, but the statistics for them are shown separately from those for the plants that were in operation during a portion or all of the year. In presenting these statistics it should be understood that although an earnest effort was made to obtain accurate information, both through the special agents in the field and by correspondence, the canvass was not so careful and thorough for this class of stations as for those in operation; some may therefore have been overlooked.

TABLE 80.—*Number of stations under construction, December 31, 1907, by character of ownership and by geographic divisions.*

DIVISION.	Aggregate.	STATIONS WHICH REPORTED COST TO DATE.					STATIONS WHICH DID NOT REPORT COST TO DATE.		
		Total.	Individual.	Firm.	Incorporated company.	Municipal.	Total.	Incorporated company.	Municipal.
United States	96	86	11	7	54	14	10	9	1
North Atlantic	21	18	3	1	14	.....	3	3	.....
South Atlantic	19	17	.....	.....	10	7	2	1	1
North Central	24	23	4	4	10	5	1	1	.....
South Central	12	12	3	1	6	2	.....	.....	.....
Western	20	16	1	1	14	.....	4	4	.....

Of the 96 stations under construction, 86 reported the amount expended on them to December 31, 1907, and 10 claimed to be unable to answer the inquiry. The number of stations is divided among the several geographic divisions in a manner which clearly indicates that, although the expenditure for construction and the capitalization may vary largely in the geographic divisions, the construction of new stations, regardless of size, is confined to no special section, but is general throughout the country.

TABLE 81.—*Cost of construction and equipment of stations under construction, December 31, 1907, and capitalization of the incorporated companies, by character of ownership and by geographic divisions.*

DIVISION AND CHARACTER OF OWNERSHIP.	Number of stations.	Cost of construction and equipment to December 31, 1907.[1]	Authorized capitalization of the incorporated companies.
United States	96	$28,413,013	$155,615,400
Individual	11	70,740	.....
Firm	7	60,904	.....
Incorporated company	63	25,025,028	155,615,400
Municipal	15	3,256,341	.....
North Atlantic	21	1,788,223	7,570,000
Individual	3	26,040	.....
Firm	1	2,000	.....
Incorporated company	17	1,760,183	7,570,000
South Atlantic	19	7,758,175	29,775,000
Incorporated company	11	7,610,634	29,775,000
Municipal	8	147,541	.....
North Central	24	5,197,828	9,632,000
Individual	4	26,400	.....
Firm	4	16,904	.....
Incorporated company	11	2,087,724	9,632,000
Municipal	5	3,066,800	.....
South Central	12	245,535	860,400
Individual	3	12,500	.....
Firm	1	12,000	.....
Incorporated company	6	179,035	860,400
Municipal	2	42,000	.....
Western	20	13,423,252	107,778,000
Individual	1	5,800	.....
Firm	1	30,000	.....
Incorporated company	18	13,387,452	107,778,000

[1] Ten of the 96 stations failed to report the cost of construction.

Combining the cost of the stations that were under construction at the close of the year and the cost of the new equipment, extensions, etc., of operating stations gives a total of $129,325,586 as the total cost of new work during 1907. Incorporated companies owned the majority of the new stations, and their authorized capitalization, which amounted to $155,615,400, is presented merely as some indication of the magnitude

Digitized by Google

of the new enterprises that were in progress or projected but had not been completed by December 31, 1907.

TABLE 82.—*Cost of construction and equipment of stations under construction, December 31, 1907, and capitalization of the incorporated companies, by kind of power used and by geographic divisions.*

DIVISION AND KIND OF POWER.	Number of stations.	Cost of construction and equipment to December 31, 1907.[1]	Authorized capitalization of the incorporated companies.
United States	96	$28,413,013	$155,615,400
Water[2]	44	27,500,716	153,654,000
Steam	39	790,172	1,636,000
Gas	10	46,204	75,400
No power equipment	3	75,921	250,000
North Atlantic	21	1,788,223	7,570,000
Water[2]	13	1,583,830	6,779,000
Steam	4	135,922	541,000
Gas	2	5,800	25,000
No power equipment	2	62,671	225,000
South Atlantic	19	7,758,175	29,775,000
Water	9	7,572,134	29,730,000
Steam	10	186,041	45,000
North Central	24	5,197,828	9,632,000
Water	5	5,016,000	9,350,000
Steam	13	144,824	232,000
Gas	6	37,004	50,000
South Central	12	245,535	860,400
Water	1	15,000	125,000
Steam	9	227,135	735,000
Gas	2	3,400	400
Western	20	13,423,252	107,778,000
Water	16	13,313,752	107,670,000
Steam	3	96,250	83,000
No power equipment	1	13,250	25,000

[1] Ten of the 96 stations failed to report the cost of construction.
[2] Includes 2 stations having steam power also.

The bulk of the expenditure for new construction was reported for stations to be operated by water power, 96.8 per cent of the total being for plants of that character, and although classed as electric stations there is little doubt that many of them are being built primarily for the generation of electrical energy which, by means of transmission lines, will be delivered in bulk to other places from which it will be distributed for actual use. The percentages reported for the remaining stations by character of primary power were as follows: Steam, 2.8 per cent; gas, two-tenths of 1 per cent; and those not to be supplied with power equipment, three-tenths of 1 per cent.

Of the 63 incorporated companies, 9 did not report the cost of construction. The Western division reported 48.4 per cent of the total cost for water-power stations under construction. The South Atlantic division was second in the construction of water-power stations, with 27.5 per cent of the total cost of construction; the North Central, third, with 18.2 per cent; the North Atlantic, fourth, with 5.8 per cent; and the South Central last, with one-tenth of 1 per cent of the total cost of construction for stations which were to use water power.

The following statement shows the character of ownership of the stations under construction, by kind of power:

Stations under construction, December 31, 1907—Number of stations, by kind of power and by character of ownership.

CHARACTER OF OWNERSHIP.	Total.	Water.[1]	Steam.	Gas.	No power equipment.
Total	96	44	39	10	3
Individual	11	4	4	3	.....
Firm	7	2	3	2	.....
Corporation	63	37	18	5	3
Municipal	15	1	14	.....	.....

[1] Includes 2 stations having steam power also.

Digitized by Google

CHAPTER VII.

INCOME AND EXPENSES.

Purpose of the statistics.—The object in view in securing these statistics concerning income and expenses was to show the magnitude of the industry and to bring out certain of its important features. No attempt was made to secure figures from which the profits or losses on the year's business might be determined, as it was well understood that conclusions on this point could not properly be drawn from information which failed to take into consideration bad debts, discounts, depreciation, and perhaps other important matters of a similar character. As has already been explained, a small part of the income as given in this report does not represent cash receipts or actual receipts of any character, since in the case of municipal plants the estimated value of the current furnished for the municipality was classed as income, and similar estimates were made by the commercial stations for the value of the current supplied as free service.

In 1902 there were 380 commercial stations which furnished some service or paid a cash compensation in the character of a tax to the municipalities in which they were located. The value of the free service was estimated at $150,809 and the cash compensation was $199,423, making a total of $350,232. In 1907 the inquiry as to compensation for franchise was abandoned, and in its stead the estimated value of current furnished free was called for. For the year last named, 727 commercial companies reported free service, the value of which was estimated at $337,810. If to this amount is added the estimated value of the current furnished by the municipal stations for the use of the municipality, $5,672,785, a total of $6,010,595 was classed as income which does not represent actual receipts.

GENERAL STATISTICS OF INCOME.

Although most of the income, 96.6 per cent, was derived from the sale of current, a small proportion, 3.4 per cent, was obtained from the sale of supplies and fixtures and from sundry miscellaneous sources. So far as possible, the income from the sale of supplies and fixtures was omitted from the reports, and is included only when such sales were so involved with the general business of the station that they could not be satisfactorily segregated. The income from miscellaneous sources includes such items as income from steam heating, pumping, steam or water power, rentals of machines, etc., wiring of houses and work of a kindred character, interest on deposits, etc. The details pertaining to income will be taken up in the tables which follow.

The chief items of income for commercial and municipal stations are shown in Table 83.

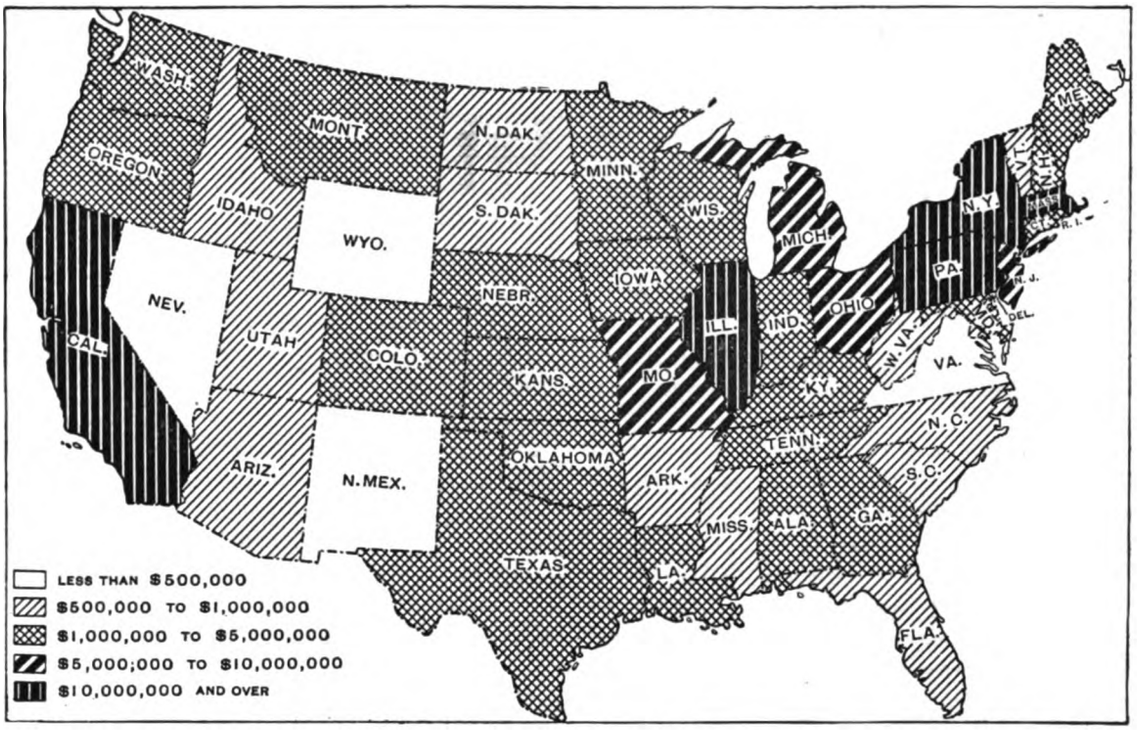
TABLE 83.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—GROSS INCOME: 1907 AND 1902.

	Census.	Total.	Commercial.	Municipal.	PER CENT OF TOTAL.		PER CENT OF INCREASE.		
					Commercial.	Municipal.	Total.	Commercial.	Municipal.
Number of stations	1907	4,714	3,462	1,252	73.4	26.6	30.2	23.4	53.6
	1902	3,620	2,805	815	77.5	22.5			
Gross income	1907	$175,642,338	$161,630,339	$14,011,999	92.0	8.0	105.0	105.3	101.2
	1902	85,700,605	78,735,500	6,965,105	91.9	8.1			
Electric service	1907	169,614,691	156,000,257	13,614,434	92.0	8.0	101.5	101.7	99.1
	1902	84,186,605	77,349,749	6,836,856	91.9	8.1			
Lighting	1907	125,755,114	112,714,851	13,040,263	89.6	10.4	79.3	77.8	93.2
	1902	70,138,147	63,389,284	6,748,863	90.4	9.6			
Stationary motors	1907	28,511,550	27,995,177	516,373	98.2	1.8	187.7	184.5	632.0
	1902	9,910,217	9,839,677	70,540	99.3	0.7			
All other	1907	15,348,027	15,290,229	57,798	99.6	0.4	270.9	271.1	231.2
	1902	4,138,241	4,120,788	17,453	99.6	0.4			
All other sources	1907	6,027,647	5,630,082	397,565	93.4	6.6	298.1	306.3	210.0
	1902	1,514,000	1,385,751	128,249	91.5	8.5			

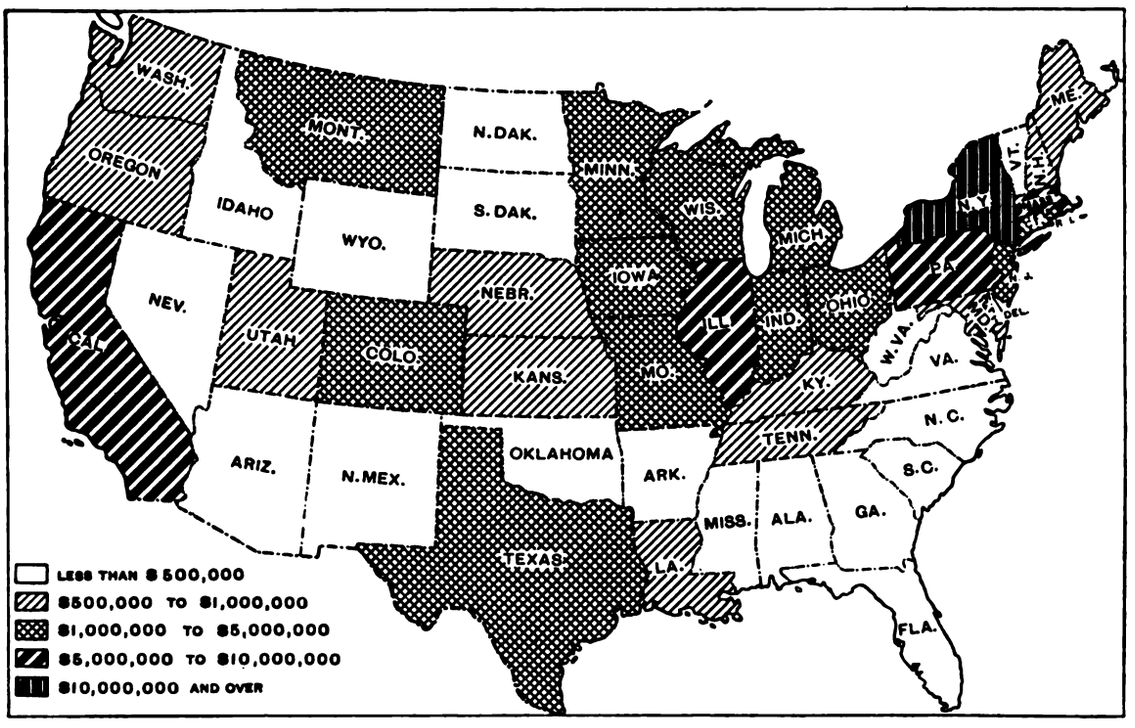
Of the different classes of income, that from lighting shows the largest actual amount, although measured by its percentage of increase it was the smallest. The earlier work of the central stations was chiefly in the direction of lighting, which as a consequence was highly developed in 1902; while stationary-motor service and, to a still greater extent, the sale of current for miscellaneous purposes are of later development.

Digitized by Google

MAP 2.—CENTRAL ELECTRIC STATIONS—GROSS INCOME: 1907.



MAP 3.—CENTRAL ELECTRIC STATIONS—GROSS INCOME: 1902.



Digitized by Google

Although the municipal stations formed nearly 27 per cent of the total number of central stations, their proportion of the total income was only 8 per cent. The business of the municipal stations is practically confined to electric lighting. The income of these stations from stationary-motor service was less than 2 per cent of the total for that item for all stations, while the income from all other electric service, which embraces current sold to other electric companies and to railways, for charging automobiles, etc., was insignificant, forming less than one-half of 1 per cent of the total for this item.

The per cent distribution of the gross income for commercial and municipal stations is shown in Table 84.

It is apparent from the table that a considerable change has taken place in the relative importance of the various classes of income from electric service. The percentage that the income from lighting forms of the total income shows a decrease of 10.2, while the proportions for income from stationary-motor service and all other electric service, and from all other sources, increased considerably.

TABLE 84.—*Commercial and municipal central electric stations—Per cent distribution of gross income: 1907 and 1902.*

	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Gross income	100.0	100.0	100.0	100.0	100.0	100.0
Electric service	96.6	98.2	96.5	98.2	97.2	98.2
Lighting	71.6	81.8	69.7	80.5	93.1	96.9
Stationary motors	16.2	11.6	17.3	12.5	3.7	1.0
All other	8.7	4.8	9.5	5.2	0.4	0.3
All other sources	3.4	1.8	3.5	1.8	2.8	1.8

In some instances there is no real difference between the character of service performed by the purely electric stations, or those engaged only in the generation or sale of electricity, or both, and the composite stations, which embrace those also engaged in some other business; but in view of the fact that in many instances the electric branch of the industry for the latter class of stations was only incident to another pursuit, they have been given a separate presentation in various tables of this report. The income for the purely electric and the composite stations is shown in Table 85.

TABLE 85.—PURELY ELECTRIC AND COMPOSITE CENTRAL ELECTRIC STATIONS—GROSS INCOME: 1907 AND 1902

	Census.	Total.	Purely electric.	Composite.	PER CENT OF TOTAL.		PER CENT OF INCREASE.		
					Purely electric.	Composite.	Total.	Purely electric.	Composite.
Number of stations	1907	4,714	2,648	2,066	56.2	43.8	30.2	23.8	39.5
	1902	3,620	2,139	1,481	59.1	40.9			
Gross income	1907	$175,642,338	$107,974,921	$67,667,417	61.5	38.5	105.0	84.2	149.7
	1902	85,700,605	58,603,406	27,097,199	68.4	31.6			
Electric service	1907	169,614,691	104,629,574	64,985,117	61.7	38.3	101.5	82.1	143.2
	1902	84,186,605	57,470,597	26,716,008	68.3	31.7			
Lighting	1907	125,755,114	75,678,052	50,077,062	60.2	39.8	79.3	61.7	114.7
	1902	70,138,147	46,812,428	23,325,719	66.7	33.3			
Stationary motors	1907	28,511,550	18,213,001	10,298,549	63.9	36.1	187.7	156.5	266.5
	1902	9,910,217	7,100,519	2,809,698	71.6	28.8			
All other	1907	15,348,027	10,738,521	4,609,506	70.0	30.0	270.9	201.8	694.0
	1902	4,138,241	3,557,650	580,591	86.0	14.0			
All other sources	1907	6,027,647	3,345,347	2,682,300	55.5	44.5	298.1	195.3	603.7
	1902	1,514,000	1,132,809	381,191	74.8	25.2			

That the character of the electric service of these two classes of stations taken as a whole is becoming more uniform is evidenced by the absence in 1907 of the wide divergence, so noticeable in 1902, in the proportions of the several items of income credited to each. Both in 1907 and in 1902 the composite stations showed their largest proportion of the income from electric service for lighting, and their smallest for all other electric service; but while the difference in the percentage of these two classes of income which was credited to composite stations was 19.3 in 1902, it was only 9.8 in 1907.

The actual increases for all classes of income from electric service and for the gross income were greater for the purely electric stations, while the composite stations showed a slightly larger actual gain in the income from "all other sources." The percentages of increase, however, are in every case greater for the composite stations, so that the proportions of the different classes of income shown for this class of stations were considerably greater in 1907 than in 1902.

The per cent distribution of the gross income for purely electric and composite stations is shown in Table 86.

Digitized by Google

TABLE 86.—*Purely electric and composite central electric stations—Per cent distribution of gross income: 1907 and 1902.*

	TOTAL.		PURELY ELECTRIC.		COMPOSITE.	
	1907	1902	1907	1902	1907	1902
Gross income	100.0	100.0	100.0	100.0	100.0	100.0
Electric service	96.6	98.2	96.9	98.1	96.0	98.6
Lighting	71.6	81.8	70.1	79.9	74.0	86.1
Stationary motors	16.2	11.6	16.9	12.1	15.2	10.4
All other	8.7	4.8	9.9	6.1	6.8	2.1
All other sources	3.4	1.8	3.1	1.9	4.0	1.4

In 1907 the purely electric stations constituted a smaller proportion of the total number of establishments than in 1902, and also contributed a smaller percentage of the gross income. Table 86 shows that of the total income from electric service, the percentage of income from lighting for the purely electric stations was smaller in 1907 than in 1902, but slightly greater for the income from stationary-motor service, "All other electric service," and "All other sources."

The gross income will be presented by dynamo capacity of the stations in several tables which follow.

TABLE 87.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—GROSS INCOME, BY DYNAMO CAPACITY OF STATIONS: 1907 AND 1902.

	Census.	Total.	Under 200 kilowatts.	200 but under 500 kilowatts.	500 but under 1,000 kilowatts.	1,000 but under 2,000 kilowatts.	2,000 but under 5,000 kilowatts.[1]	5,000 kilowatts and over.	Stations having no generating equipment.
Number of stations	1907	4,714	3,038	821	269	169	116	74	227
	1902	3,620	2,587	586	172	98	67	32	78
Gross income	1907	$175,642,338	$17,140,070	$14,786,719	$10,465,110	$13,149,808	$21,915,199	$89,930,073	$8,255,359
	1902	85,700,605	14,440,351	10,409,319	7,001,486	8,414,307	13,839,846	30,027,061	1,568,235
Electric service	1907	169,614,691	16,344,745	13,954,088	10,075,476	12,617,855	21,277,402	87,277,832	8,067,293
	1902	84,186,605	14,090,189	10,122,092	6,896,143	8,175,941	13,635,206	29,756,206	1,510,828
Lighting	1907	125,755,114	15,779,128	12,547,375	8,267,158	9,274,623	15,355,491	58,957,999	5,573,340
	1902	70,138,147	13,741,455	9,317,862	5,832,733	6,385,817	10,875,989	22,964,304	1,019,987
Stationary motors	1907	28,511,550	386,329	1,094,952	1,240,926	2,190,200	4,353,295	17,621,388	1,624,460
	1902	9,910,217	228,578	598,897	682,445	1,263,138	2,034,955	4,824,518	277,686
All other	1907	15,348,027	179,288	311,761	567,392	1,153,032	1,568,616	10,698,445	869,493
	1902	4,138,241	120,156	205,333	380,965	526,986	724,262	1,967,384	213,155
All other sources	1907	6,027,647	795,325	832,631	389,634	531,953	637,797	2,652,241	188,066
	1902	1,514,000	350,162	287,227	105,343	238,366	204,640	270,855	57,407

[1] Includes 1 municipal station with a kilowatt capacity of 5,000 or over.

Of the six classes of stations grouped according to dynamo capacity, the largest income is shown for the class smallest in numbers, stations having a kilowatt capacity of 5,000 or over. In 1907 more than one-half of the total income was reported by this class, which naturally embraces the stations in the large cities. The next largest income is shown for the next lower group by kilowatt capacity and the next higher in number of stations; but the group ranking third in the amount of income reported is that which comprises the stations of smallest dynamo capacity, which, however, includes nearly two-thirds of the total number of stations. Almost 5 per cent of the total income was reported by stations not equipped with generating apparatus. The proportions of the total income from lighting reported for the different classes of stations vary but little from the corresponding proportions of total income, but in the case of income from stationary-motor service and all other electric service the proportions show decided variations. This results from the fact that the income from each of these two classes of service increases as the dynamo capacity of the stations grows larger. In 1907 the smallest stations, those with a dynamo capacity of less than 200 kilowatts, reported but 1.4 per cent of the total income for motor service, while the stations of largest dynamo capacity reported 61.8 per cent. In the case of income from all other electric service the corresponding proportions were 1.2 per cent and 69.7 per cent. From this it is clear that the business of the small stations is almost exclusively confined to lighting, while the larger stations are, to a considerable extent, engaged in performing other services.

There is a marked difference between the commercial and the municipal stations in respect to the proportions of income reported by large and small plants. While the commercial stations show their largest proportions for the two classes of highest individual capacity, the municipal stations show their largest proportions for the two of lowest individual capacity. The gross income for the class of smallest dynamo capacity for municipal stations represented more than one-third of the total, while that for the class of next higher dynamo capacity was nearly as much as the total for all the remaining classes. The two classes together reported 67.6 per cent of the total income and 92.6 per cent of the total number of stations.

Digitized by Google

TABLE 88.—COMMERCIAL CENTRAL ELECTRIC STATIONS—GROSS INCOME, BY DYNAMO CAPACITY OF STATIONS: 1907 AND 1902.

	Census.	Total.	Under 200 kilowatts.	200 but under 500 kilowatts.	500 but under 1,000 kilowatts.	1,000 but under 2,000 kilowatts.	2,000 but under 5,000 kilowatts.	5,000 kilowatts and over.	Stations having no generating equipment.
Number of stations	1907	3,462	2,116	584	225	159	111	74	193
	1902	2,805	1,890	497	160	92	64	32	70
Gross income	1907	$161,630,339	$11,725,245	$10,727,632	$8,903,772	$12,077,872	$20,568,767	$89,930,073	$7,696,978
	1902	78,735,500	10,582,929	8,980,913	6,688,819	7,922,180	13,107,024	30,027,061	1,426,574
Electric service	1907	156,000,257	11,117,146	10,036,132	8,539,111	11,554,325	19,949,795	87,277,832	7,525,916
	1902	77,349,749	10,309,190	8,725,433	6,589,544	7,683,814	12,915,920	29,756,206	1,369,642
Lighting	1907	112,714,851	10,621,562	8,837,815	6,845,383	8,328,039	14,070,217	58,957,999	5,053,836
	1902	63,389,284	9,992,266	7,952,853	5,533,734	5,905,006	10,156,839	22,964,304	884,282
Stationary motors	1907	27,995,177	331,416	908,089	1,140,919	2,076,288	4,313,891	17,621,388	1,603,186
	1902	9,839,677	210,925	569,863	675,525	1,251,822	2,034,819	4,824,518	272,205
All other	1907	15,290,229	164,168	290,228	552,809	1,149,998	1,565,687	10,698,445	868,894
	1902	4,120,788	105,999	202,717	380,285	526,986	724,262	1,967,384	213,155
All other sources	1907	5,630,082	608,099	691,500	364,661	523,547	618,972	2,652,241	171,062
	1902	1,385,751	273,739	255,480	99,275	238,366	191,104	270,855	56,932

TABLE 89.—MUNICIPAL CENTRAL ELECTRIC STATIONS—GROSS INCOME, BY DYNAMO CAPACITY OF STATIONS: 1907 AND 1902.

	Census.	Total.	Under 200 kilowatts.	200 but under 500 kilowatts.	500 but under 1,000 kilowatts.	1,000 but under 2,000 kilowatts.	2,000 but under 5,000 kilowatts.[1]	Stations having no generating equipment.
Number of stations	1907	1,252	922	237	44	10	5	34
	1902	815	697	89	12	6	3	8
Gross income	1907	$14,011,999	$5,414,825	$4,059,087	$1,561,338	$1,071,936	$1,346,432	$558,381
	1902	6,965,105	3,857,422	1,428,406	312,667	492,127	732,822	141,661
Electric service	1907	13,614,434	5,227,599	3,917,956	1,536,365	1,063,530	1,327,607	541,377
	1902	6,836,856	3,780,999	1,396,659	306,599	492,127	719,286	141,186
Lighting	1907	13,040,263	5,157,566	3,709,560	1,421,775	946,584	1,285,274	519,504
	1902	6,748,863	3,749,189	1,365,009	298,999	480,811	719,150	135,705
Stationary motors	1907	516,373	54,913	186,863	100,007	113,912	39,404	21,274
	1902	70,540	17,653	29,034	6,920	11,316	136	5,481
All other	1907	57,798	15,120	21,533	14,583	3,034	2,929	599
	1902	17,453	14,157	2,616	680	.....	.....	.....
All other sources	1907	397,565	187,226	141,131	24,973	8,406	18,825	17,004
	1902	128,249	76,423	31,747	6,068	.....	13,536	475

[1] Includes 1 station having a capacity of more than 5,000 kilowatts.

By a reference to Tables 90 and 91 it will be seen that the proportions of the total income of the purely electric and the composite commercial stations reported for the different groups according to dynamo capacity are similar to those shown for the two classes combined. The same may be said of the proportions shown for the purely electric and the composite municipal stations as compared with those shown for all municipal stations. It is noteworthy that in 1907 the stations of smallest dynamo capacity reported a smaller proportion of the total income both of the purely electric and of the composite municipal stations than in 1902.

TABLE 90.—PURELY ELECTRIC COMMERCIAL STATIONS—GROSS INCOME, BY DYNAMO CAPACITY OF STATIONS: 1907 AND 1902.

	Census.	Total.	Under 200 kilowatts.	200 but under 500 kilowatts.	500 but under 1,000 kilowatts.	1,000 but under 2,000 kilowatts.	2,000 but under 5,000 kilowatts.	5,000 kilowatts and over.	Stations having no generating equipment.
Number of stations	1907	2,127	1,314	350	114	76	66	47	160
	1902	1,759	1,176	311	86	65	46	22	53
Gross income	1907	$101,222,267	$7,506,219	$5,994,937	$3,874,663	$5,221,022	$12,820,831	$59,664,130	$6,140,465
	1902	54,455,737	6,695,183	5,315,200	3,239,659	5,525,615	10,003,345	22,025,474	1,051,261
Electric service	1907	98,056,838	7,107,234	5,634,988	3,751,269	4,952,687	12,582,827	58,006,040	6,021,793
	1902	53,394,158	6,504,590	5,127,766	3,183,899	5,352,780	9,831,193	22,387,101	1,006,829
Lighting	1907	69,383,375	6,777,126	5,009,071	2,973,428	3,281,487	8,630,737	38,845,455	3,866,071
	1902	42,804,000	6,354,594	4,665,079	2,575,351	4,036,559	7,611,473	16,996,183	564,761
Stationary motors	1907	17,951,940	211,841	465,406	470,393	1,002,524	3,064,162	11,421,189	1,316,425
	1902	7,049,444	88,188	354,540	337,603	907,706	1,553,371	3,579,123	228,913
All other	1907	10,721,523	118,267	160,511	307,448	668,676	887,928	7,739,396	839,297
	1902	3,540,714	61,808	108,147	270,945	408,515	666,349	1,811,795	213,155
All other sources	1907	3,165,429	398,985	359,949	123,394	268,335	238,004	1,658,090	118,672
	1902	1,061,579	190,593	187,434	55,760	172,835	172,152	238,373	44,432

Digitized by Google

TABLE 91.—COMPOSITE COMMERCIAL STATIONS—GROSS INCOME, BY DYNAMO CAPACITY OF STATIONS: 1907 AND 1902.

	Census.	Total.	Under 200 kilowatts.	200 but under 500 kilowatts.	500 but under 1,000 kilowatts.	1,000 but under 2,000 kilowatts.	2,000 but under 5,000 kilowatts.	5,000 kilowatts and over.	Stations having no generating equipment.
Number of stations	1907	1,335	802	234	111	83	45	27	33
	1902	1,046	714	186	74	27	18	10	17
Gross income	1907	$60,408,072	$4,219,026	$4,732,695	$5,029,109	$6,856,850	$7,747,936	$30,205,943	$1,556,513
	1902	24,279,763	3,887,746	3,665,713	3,449,160	2,396,565	3,103,679	7,401,587	375,313
Electric service	1907	57,943,419	4,009,912	4,401,144	4,787,842	6,601,638	7,366,968	29,271,792	1,504,123
	1902	23,955,591	3,804,600	3,597,667	3,405,645	2,331,034	3,084,727	7,369,105	362,813
Lighting	1907	43,331,476	3,844,436	3,828,744	3,871,955	5,046,552	5,439,480	20,112,544	1,187,765
	1902	20,585,284	3,637,672	3,287,774	2,958,383	1,868,447	2,545,366	5,968,121	319,521
Stationary motors	1907	10,043,237	119,575	442,683	670,526	1,073,764	1,249,729	6,200,199	286,761
	1902	2,790,233	122,737	215,323	337,922	344,116	481,448	1,245,395	43,292
All other	1907	4,568,706	45,901	129,717	245,361	481,322	677,759	2,959,049	29,597
	1902	580,074	44,191	94,570	109,340	118,471	57,913	155,589	.....
All other sources	1907	2,464,653	209,114	331,551	241,267	255,212	380,968	994,151	52,390
	1902	324,172	83,146	68,046	43,515	65,531	18,952	32,482	12,500

TABLE 92.—PURELY ELECTRIC MUNICIPAL STATIONS—GROSS INCOME, BY DYNAMO CAPACITY OF STATIONS: 1907 AND 1902.

	Census.	Total.	Under 200 kilowatts.	200 but under 500 kilowatts.	500 but under 1,000 kilowatts.	1,000 but under 2,000 kilowatts.	2,000 but under 5,000 kilowatts.[1]	Stations having no generating equipment.
Number of stations	1907	521	378	86	26	4	5	22
	1902	380	301	55	10	4	3	7
Gross income	1907	$6,752,654	$2,007,991	$1,589,617	$1,021,748	$336,881	$1,346,432	$449,985
	1902	4,147,669	1,672,765	921,067	257,190	423,964	732,822	139,861
Electric service	1907	6,572,736	1,936,132	1,525,810	1,004,526	335,928	1,327,607	442,733
	1902	4,076,439	1,644,044	897,580	252,179	423,964	719,286	139,386
Lighting	1907	6,294,677	1,917,550	1,432,399	925,765	304,592	1,285,274	429,097
	1902	4,008,428	1,622,891	869,765	244,579	418,138	719,150	133,905
Stationary motors	1907	261,061	16,269	90,379	70,948	31,000	39,404	13,061
	1902	51,075	7,513	25,199	6,920	5,826	136	5,481
All other	1907	16,998	2,313	3,032	7,813	336	2,929	575
	1902	16,936	13,640	2,616	680	.....	.....	.....
All other sources	1907	179,918	71,859	63,807	17,222	953	18,825	7,252
	1902	71,230	28,721	23,487	5,011	.....	13,536	475

[1] Includes 1 station having a capacity of more than 5,000 kilowatts.

TABLE 93.—COMPOSITE MUNICIPAL STATIONS—GROSS INCOME, BY DYNAMO CAPACITY OF STATIONS: 1907 AND 1902.

	Census.	Total.	Under 200 kilowatts.	200 but under 500 kilowatts.	500 but under 1,000 kilowatts.	1,000 but under 2,000 kilowatts.	Stations having no generating equipment.
Number of stations	1907	731	544	151	18	6	12
	1902	435	396	34	2	2	1
Gross income	1907	$7,259,345	$3,406,834	$2,469,470	$539,590	$735,055	$108,396
	1902	2,817,436	2,184,657	507,339	55,477	68,163	1,800
Electric service	1907	7,041,698	3,291,467	2,392,146	531,839	727,602	98,644
	1902	2,760,417	2,136,955	499,079	54,420	68,163	1,800
Lighting	1907	6,745,586	3,240,016	2,277,161	496,010	641,992	90,407
	1902	2,740,435	2,126,298	495,244	54,420	62,673	1,800
Stationary motors	1907	255,312	38,644	96,484	29,059	82,912	8,213
	1902	19,465	10,140	3,835	.....	5,490	.....
All other	1907	40,800	12,807	18,501	6,770	2,698	24
	1902	517	517	.....	.....	.....	.....
All other sources	1907	217,647	115,367	77,324	7,751	7,453	9,752
	1902	57,019	47,702	8,260	1,057	.....	.....

Digitized by Google

The extent to which the income is confined to a few states is illustrated by showing the detailed income for the 10 selected states in Table 94.

At each of the two censuses almost 70 per cent of the gross income for all central stations was reported by the 10 states for which figures are given in Table 94, the proportion in 1907 and in 1902 varying but three-tenths of 1 per cent. Notwithstanding the large increases in the income for each state, there were several which in 1907 showed considerably decreased proportions of the total income reported, as follows: Pennsylvania, from 11.1 per cent to 9.1 per cent; Massachusetts, from 7.4 per cent to 6.1 per cent; Ohio, from 5.2 per cent to 4.4 per cent; and New Jersey, from 4 per cent to 3.4 per cent. The states which increased their proportions were New York, Illinois, California, Michigan, and Missouri. California and Illinois show the most pronounced growth in the gross income, although the total actual increase for the 2 states combined was only $54,759 more than the increase for New York alone.

TABLE 94.—CENTRAL ELECTRIC STATIONS—GROSS INCOME FOR 10 SELECTED STATES: 1907 AND 1902.

STATE	Census.	Number of stations.	Gross income.	Lighting.	Stationary-motor service.	All other electric service.	All other sources.
Total for United States	1907	4,714	$175,642,338	$125,755,114	$28,511,550	$15,348,027	$6,027,647
	1902	3,620	85,700,605	70,138,147	9,910,217	4,138,241	1,514,000
Total for 10 selected states	1907	2,205	121,418,869	86,140,793	19,744,151	11,717,114	3,816,811
	1902	1,911	59,469,531	48,490,347	7,136,945	2,928,759	913,480
New York	1907	314	34,859,170	24,296,438	5,688,401	4,082,544	791,787
	1902	256	16,854,839	12,920,807	2,396,046	1,425,386	112,600
Pennsylvania	1907	327	16,015,392	12,081,602	2,101,320	1,217,878	614,592
	1902	279	9,486,867	8,321,766	640,948	348,702	175,451
Illinois	1907	383	15,465,993	10,278,668	2,445,280	1,842,824	899,221
	1902	346	6,757,015	5,849,351	763,764	79,133	64,767
California	1907	129	14,416,529	8,111,012	3,826,462	1,984,554	494,501
	1902	115	5,066,417	3,305,318	1,228,099	412,673	120,327
Massachusetts	1907	120	10,749,240	8,543,327	1,519,708	539,463	146,742
	1902	114	6,340,944	5,263,113	744,879	236,890	96,062
Ohio	1907	272	7,643,997	6,282,861	1,054,076	138,043	169,017
	1902	233	4,431,038	3,873,339	407,901	66,266	83,532
Michigan	1907	234	6,072,010	3,848,797	873,061	1,028,569	321,563
	1902	201	2,613,812	2,285,995	173,881	56,924	97,012
New Jersey	1907	64	5,952,378	5,123,926	682,028	104,791	41,633
	1902	64	3,421,304	2,799,961	258,055	298,583	64,705
Missouri	1907	162	5,805,828	4,116,409	985,596	581,790	122,033
	1902	123	2,392,149	1,954,562	402,937	2,651	31,999
Indiana	1907	200	4,438,332	3,457,753	568,199	196,658	215,722
	1902	180	2,105,146	1,916,135	120,435	1,551	67,025

The per cent distribution and per cent of increase of the gross income for the 10 selected states is shown in Table 95.

TABLE 95.—*Central electric stations—Per cent distribution and per cent of increase for gross income in 10 selected states: 1907 and 1902.*

STATE.	PER CENT DISTRIBUTION.		Per cent of increase.
	1907	1902	
Total for United States	100.0	100.0	104.9
Total for 10 selected states	69.1	69.4	104.2
New York	19.8	19.7	106.8
Pennsylvania	9.1	11.1	68.8
Illinois	8.8	7.9	128.9
California	8.2	5.9	184.6
Massachusetts	6.1	7.4	69.5
Ohio	4.4	5.2	72.5
Michigan	3.5	3.0	132.3
New Jersey	3.4	4.0	74.0
Missouri	3.3	2.8	142.7
Indiana	2.5	2.5	110.8

Other states not included in Table 94 which report large incomes for 1907 for central electric stations are, Texas, $3,792,203; Minnesota, $3,478,009; Washington, $3,410,542; Colorado, $3,410,240; Iowa, $2,479,969; Connecticut, $2,469,543; Montana, $2,469,131; and Wisconsin, $2,278,637. The income reported for the state of Washington is especially noteworthy, being an increase of $2,626,891, or 335.2 per cent, over 1902. Washington is one of the states which relies largely upon water for primary power, and to the abundance of this economical force for the generation of electricity may be traced its relatively large use in that state.

The income of stations classified according to kind of primary power used and the percentages of increase are shown in Tables 96 and 97.

Digitized by Google

TABLE 96.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—GROSS INCOME, BY KIND OF PRIMARY POWER USED: 1907 AND 1902.

	Census.	Total.	Steam exclusively.	Steam with other minor power.	Water exclusively.	Water with other minor power.	Water and steam.	Gas exclusively.	Stations without primary-power equipment.
Number of stations	1907	4,714	3,262	93	474	61	360	180	284
	1902	3,620	2,747	43	315	20	275	51	169
Gross income	1907	$175,642,338	$119,029,194	$7,967,002	$11,098,303	$3,104,158	$22,700,921	$1,010,150	$10,732,610
	1902	85,700,605	64,730,694	3,357,962	4,156,505	1,069,866	9,052,574	775,137	2,567,867
Electric service	1907	169,614,691	115,428,251	7,821,550	10,454,035	2,946,122	21,507,904	980,910	10,475,919
	1902	84,186,605	63,795,608	3,237,584	4,035,702	1,034,880	8,812,006	769,900	2,500,925
Lighting	1907	125,755,114	92,462,389	6,582,067	3,621,562	1,702,752	13,152,818	884,204	7,349,322
	1902	70,138,147	55,439,357	2,755,445	2,165,746	121,058	7,004,961	706,036	1,945,544
Stationary motors	1907	28,511,550	15,934,961	1,007,776	2,986,379	918,658	5,464,061	82,221	2,117,494
	1902	9,910,217	6,886,244	331,031	986,075	80,011	1,246,918	63,741	316,197
All other	1907	15,348,027	7,030,901	231,707	3,846,094	324,712	2,891,025	14,485	1,009,103
	1902	4,138,241	1,470,007	151,106	883,881	833,811	560,127	123	239,184
All other sources	1907	6,027,647	3,600,943	145,452	644,268	158,036	1,193,017	29,240	256,691
	1902	1,514,000	935,086	120,378	120,803	24,986	240,568	5,237	66,942

TABLE 97.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—PER CENT OF INCREASE OF GROSS INCOME, BY KIND OF PRIMARY POWER USED: 1907.

	Total.	Steam exclusively.	Steam with other minor power.	Water exclusively.	Water with other minor power.	Water and steam.	Gas exclusively.	Stations without primary-power equipment.
Number of stations	30.2	18.7	116.3	50.5	205.0	30.9	252.9	68.0
Gross income	105.9	83.9	137.3	167.0	192.9	150.8	30.3	318.0
Electric service	101.5	80.9	141.6	159.0	184.7	144.1	27.4	319.0
Lighting	79.3	66.8	138.9	67.2	1,306.6	87.8	25.2	277.8
Stationary motors	187.7	131.4	204.4	202.9	1,048.2	338.2	29.0	569.6
All other	270.9	378.3	53.3	335.1	[1] 61.1	416.1	11,676.4	321.9
All other sources	298.1	285.1	20.8	433.3	532.5	395.9	458.3	283.5

[1] Decrease.

In another chapter of this report reference is made to the fact that allowance must be made for changes from year to year in the equipment of existing stations in respect to the primary power employed, which would result in the transfer of stations from one class to another without materially adding to the total power equipment. The tables, therefore, should be accepted more as representing the conditions at the two censuses, and as showing the increase in the income reported for the stations using the different kinds of power, rather than as showing the actual growth in the use of any particular kind of primary power.

In 1907 the income for the steam plants, including the stations exclusively equipped with steam power and those which also had other minor power, constituted 72.3 per cent of the total. Even this large proportion does not fully indicate the relative importance of the income resulting from using steam as the primary power, since the stations which were about equally equipped with steam and with water power reported 12.9 per cent of the total gross income, some part of which should rightfully be classed as resulting from the use of steam. If this amount was divided equally between water and steam, approximately 78.7 per cent of the gross income would be credited as income derived from the use of steam as the primary power, leaving but little more than one-fifth of the income to be divided among the three remaining classes, water-power stations, gas-power stations, and those stations having no primary power. Of these three classes, the stations using water exclusively, or water with other minor power, reported 8.1 per cent of the total income, and if to the income for these stations is added half of the amount reported for stations using both water and steam, the total income derived from the use of water power would represent approximately 14.6 per cent of the total gross income reported. The stations using gas reported but six-tenths of 1 per cent of the total gross income, and those purchasing their power, while showing large and most consistent percentages of increase in each of the several sources of income, reported but 6.1 per cent.

The proportion of income derived from each source is shown for the different classes of stations in Table 98.

Digitized by Google

TABLE 98.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—PER CENT DISTRIBUTION OF GROSS INCOME FOR EACH KIND OF POWER USED, BY SOURCE OF INCOME: 1907 AND 1902.

	Census.	Total.	Steam exclusively.	Steam with other minor power.	Water exclusively.	Water with other minor power.	Water and steam.	Gas exclusively.	Stations without primary-power equipment.
Gross income	1907	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	1902	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Electric service	1907	96.6	97.0	98.2	94.2	94.9	94.7	97.1	97.6
	1902	98.2	98.6	96.4	97.1	97.6	97.3	99.3	97.4
Lighting	1907	71.6	77.7	82.6	32.6	54.9	57.9	87.5	68.5
	1902	81.8	85.6	82.1	52.1	11.4	77.4	91.1	75.8
Stationary motors	1907	16.2	13.4	12.6	26.9	29.6	24.1	8.1	19.7
	1902	11.6	10.6	9.9	23.7	7.5	13.8	8.2	12.3
All other	1907	8.7	5.9	2.9	34.7	10.5	12.7	1.4	9.4
	1902	4.8	2.3	4.5	21.3	78.7	6.2	(1)	9.3
All other sources	1907	3.4	3.0	1.8	5.8	5.1	5.3	2.9	2.4
	1902	1.8	1.4	3.6	2.9	2.4	2.7	0.7	2.6

[1] Less than one-tenth of 1 per cent.

A noteworthy feature of the central-station industry is the relatively small proportion of the total income of the stations using water power which is received from lighting. In 1907 the proportion obtained from this source was smallest (32.6 per cent) for the stations using water power exclusively. On the other hand, the stations using water power show exceptionally large proportions of their income as derived from motor service and from all other electric service. These results are in accordance with the well-known fact that many of the stations equipped with water power sell much of their current to other electric stations or to establishments which use it for motor service, etc. If the proportionate income from lighting reported for 1907 by the three classes using water power is considered separately in relation to the corresponding amounts for 1902, unaccountable differences are found; but when the three classes are considered together the discrepancies disappear. The differences referred to result, no doubt, from minor changes of equipment which transferred stations from one class to another, but still kept them among those using water power.

The sale of current in bulk has grown to large proportions and constitutes a special branch of the electrical industry. Although a number of stations engaged in it were operated by steam as the primary power, most of the stations that make a specialty of this form of service are hydro-electric plants. In 1907 there were 92 stations, operated either exclusively or primarily by water power, the chief business of which was the sale of current in bulk, this current being transmitted to greater or less distances as necessity demanded. These 92 stations reported a total income of $13,231,720, of which $8,783,371, or 66.4 per cent, was from current sold in bulk; $2,675,852, or 20.2 per cent, from lighting; $1,221,408, or 9.2 per cent, from all other electric service; and $551,089, or 4.2 per cent, from sources other than the sale of electricity.

Table 99 shows the income of stations with and those without meters on consumption circuits.

TABLE 99.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—GROSS INCOME FOR STATIONS WITH AND WITHOUT METERS ON CONSUMPTION CIRCUITS: 1907 AND 1902.

	Census.	TOTAL.			COMMERCIAL.			MUNICIPAL.		
		Total.	With meters.	Without meters.	Total.	With meters.	Without meters.	Total.	With meters.	Without meters.
Number of stations	1907	4,714	4,085	629	3,462	3,019	443	1,252	1,066	186
	1902	3,620	2,719	901	2,805	2,147	658	815	572	243
Gross income	1907	$175,642,338	$168,590,884	$7,051,454	$161,630,339	$157,341,176	$4,289,163	$14,011,999	$11,249,708	$2,762,291
	1902	85,700,605	79,888,904	5,811,701	78,735,500	75,254,621	3,480,879	6,965,105	4,634,283	2,330,822
Electric service	1907	169,614,691	162,702,690	6,912,001	156,000,257	151,818,384	4,181,873	13,614,434	10,884,306	2,730,128
	1902	84,186,605	78,463,821	5,722,784	77,349,749	73,944,448	3,405,301	6,836,856	4,519,373	2,317,483
Lighting	1907	125,755,114	121,749,304	4,005,810	112,714,851	111,407,611	1,307,240	13,040,263	10,341,693	2,698,570
	1902	70,138,147	65,146,516	4,991,631	63,389,284	60,696,174	2,693,110	6,748,863	4,450,342	2,298,521
Stationary motors	1907	28,511,550	27,896,922	614,628	27,995,177	27,409,632	585,545	516,373	487,290	29,083
	1902	9,910,217	9,606,409	303,808	9,839,677	9,545,887	293,790	70,540	60,522	10,018
All other	1907	15,348,027	13,056,464	2,291,563	15,290,229	13,001,141	2,289,088	57,798	55,323	2,475
	1902	4,138,241	3,710,896	427,345	4,120,788	3,702,387	418,401	17,453	8,509	8,944
All other sources	1907	6,027,647	5,888,194	139,453	5,630,082	5,522,792	107,290	397,565	365,402	32,163
	1902	1,514,000	1,425,083	88,917	1,385,751	1,310,173	75,578	128,249	114,910	13,339

Digitized by Google

The trend of the later methods of electric service is unquestionably in the direction of selling current by meter measurement. The change in this direction, which has been going on for some time, has been accelerated by advances made in the perfection of the meters. It is to the interest of the company furnishing the current to have these machines installed, not only as a matter of self-protection but because every step in the direction of reliability and accuracy is bound to win favor with the consumer.

It should be understood, in connection with Table 99, that although the figures for stations not equipped with meters are complete, as reported, this condition is not in the same degree conclusive for those classed as having meters. The latter class of stations embraces all which reported meters, and included many stations that were not fully equipped in this particular, but sold part of the current at contract or flat rates. The figures, however, demonstrate beyond question the fact that the stations without meters are decreasing in number, notwithstanding the increase in the total number of stations. In 1902, of the total number of stations, 24.9 per cent reported no meters as compared with only 13.3 per cent in 1907. The income for the stations without meters formed 6.8 per cent of the total in 1902 and but 4 per cent in 1907. There was little difference in the relative proportions of the commercial and the municipal stations which had installed meters, but a considerably larger percentage of the income of commercial stations is credited to those having meters than is the case with the municipal stations. The municipal stations have been somewhat slower in the adoption of meters, since many of them, by reason of the fact that the whole or the great bulk of the current produced is used directly by the municipality, do not feel the necessity for such equipment. In the case of the commercial stations the income for stations without meters formed 4.4 per cent of the total for such stations in 1902 and 2.7 per cent in 1907. The corresponding proportions for the municipal stations were 33.5 per cent and 19.7 per cent, respectively.

A comparison of the income of the commercial stations from the several classes of electric service in 1907 and in 1902 shows that the stations without meters reported a decreased proportion of the total in 1907 for all classes of income, except income from all other electric service, for which there was a decided gain. Of the total income from lighting, the proportion for commercial stations without meters decreased from 4.2 per cent to 1.2 per cent, while the percentage of the total income from stationary-motor service reported for this class of stations fell from 3 per cent to 2.1 per cent; in the case of income from all other electric service, however, the percentage increased from 10.2 per cent to 15 per cent. The increase in the income for this latter item is due to the fact that several companies with long-transmission lines, a business largely created since 1902, sold at wholesale large quantities of current at contract rates. In the case of the municipal stations, on the other hand, the part of the total income from all other electric service contributed by stations not equipped with meters shows a falling off from 51.2 per cent in 1902 to 4.3 per cent in 1907.

The income for commercial and for municipal lighting is shown in Table 100.

TABLE 100.—*Commercial and municipal central electric stations—Gross income from commercial and public lighting: 1907 and 1902.*

	STATIONS.		
	Total.	Commercial.	Municipal.
Lighting, 1907	$125,755,114	$112,714,851	$13,040,263
Commercial	100,337,434	92,942,447	7,394,987
Public	25,417,680	19,772,404	5,645,276
Lighting, 1902	70,138,147	63,389,284	6,748,863
Commercial	50,368,173	47,259,711	3,108,462
Public	19,769,974	16,129,573	3,640,401
Per cent of increase:			
Total	79.3	77.8	93.2
Commercial	92.2	96.7	137.9
Public	28.6	16.4	55.1

By public lighting in this report is meant the lighting of streets, parks, public buildings, and all other public places for the illumination of which the municipality or other governmental division exercising municipal functions is responsible, irrespective of whether such service was rendered by commercial or municipal stations; while commercial lighting embraces all lighting which is furnished to individuals, firms, etc., by either the commercial or the municipal stations.

The income from commercial lighting formed 79.8 per cent of the total income for all kinds of lighting in 1907 and 71.8 per cent in 1902, while the corresponding proportions for public lighting were 20.2 per cent and 28.2 per cent, respectively. Thus the percentage for commercial lighting was larger by 8 per cent in 1907 than in 1902 and the percentage for public lighting correspondingly smaller. Both the actual and the percentage of increase were much greater for commercial than for public lighting. It is apparent from Table 100 that during the period between the two censuses commercial lighting made much more rapid progress than public lighting.

The extent to which the income from lighting is confined to a few states is shown in Table 101.

Digitized by Google

TABLE 101.—CENTRAL ELECTRIC STATIONS—GROSS INCOME FROM COMMERCIAL AND PUBLIC LIGHTING, FOR 15 SELECTED STATES: 1907 AND 1902.

	TOTAL.		COMMERCIAL LIGHTING.		PUBLIC LIGHTING.	
	1907	1902	1907	1902	1907	1902
Total for United States	$125,755,114	$70,138,147	$100,337,434	$50,368,173	$25,417,680	$19,769,974
Total for 15 selected states	98,183,606	55,045,472	78,494,819	39,173,239	19,688,787	15,872,233
New York	24,296,438	12,920,807	20,430,168	9,359,493	3,866,270	3,561,314
Pennsylvania	12,081,602	8,321,766	8,790,425	5,557,115	3,291,177	2,764,651
Illinois	10,278,668	5,849,351	8,078,661	4,094,781	2,200,007	1,754,570
Massachusetts	8,543,327	5,263,113	6,315,999	3,555,731	2,227,328	1,707,382
California	8,111,012	3,305,318	7,220,210	2,737,430	890,802	567,888
Ohio	6,282,861	3,873,339	4,577,668	2,480,635	1,705,193	1,392,701
New Jersey	5,123,926	2,799,961	3,700,863	1,696,783	1,423,063	1,103,178
Missouri	4,116,409	1,954,562	3,578,819	1,610,820	537,590	343,742
Michigan	3,848,797	2,285,995	2,958,391	1,631,983	890,406	654,012
Indiana	3,457,753	1,916,135	2,572,206	1,160,712	885,547	755,423
Texas	3,066,994	1,753,681	2,745,418	1,494,712	321,576	258,969
Minnesota	2,700,959	1,615,766	2,193,540	1,267,424	507,419	348,342
Colorado	2,181,310	1,209,760	1,921,459	984,325	259,851	225,435
Washington	2,078,156	586,274	1,838,208	502,148	239,948	84,126
Iowa	2,015,394	1,389,644	1,572,784	1,039,144	442,610	350,500

The bulk of the income from lighting, 78.1 per cent in 1907 and 78.5 per cent in 1902, was reported by the stations in the 15 states shown in the table. So large a part of the total income is reported by these states that no great difference between the rates of increase for the whole United States and for the 15 states together is to be expected. For the United States the increases were as follows: Total, 79.3 per cent; commercial lighting, 99.2 per cent; public lighting, 28.6 per cent. The corresponding increases for the 15 states were 78.4 per cent, 100.4 per cent, and 24 per cent.

In the report for 1902 a statement was prepared showing the total number of arc and of incandescent lamps, together with the separate income derived from each of the two classes of service, and the average income per lamp based upon these figures. The material for a corresponding statement for 1907 is wanting, on account of the fact that to a great extent the different stations have discontinued keeping accounts giving these data because of the general adoption of the meter system of selling electricity and the fact that it is no longer necessary for the company to know the number of lamps served. Not only is it often impossible to ascertain the separate income for arc and for incandescent lamps, but there is also no way of finding out the extent to which the electric current supplied from the same wire and measured by the same meters has been used for small fan motors and for other miscellaneous purposes. Furthermore, the number of lamps called for in 1907 was the number wired for service on the last day of the year covered by the report, and not, as in 1902, the number in service. In order that some idea may be had of the relative income per lamp at the two censuses, however, a number of reports in which complete answers appear to have been made were selected and tabulated, and the results, together with the figures as published in 1902 for all commercial central stations in the United States, are presented in the following statement:

Commercial central electric stations—Average income from lamps as reported in 1902, and as obtained from 110 selected reports in 1907.

	COMMERCIAL STATIONS.	
	For 110 selected stations in 1907.	For all stations in 1902.
Arc lamps:		
Commercial lighting—		
Number of lamps	62,426	168,180
Income	$2,496,837	$8,220,154
Average income per lamp	$40.00	$48.88
Public lighting—		
Number of lamps	49,900	166,723
Income	$3,471,622	$13,871,646
Average income per lamp	$69.57	$83.20
Incandescent lamps:		
Commercial lighting—		
Number of lamps	8,841,206	16,243,853
Income	$17,532,593	$39,039,557
Average income per lamp	$1.98	$2.40
Public lighting—		
Number of lamps	112,062	372,740
Income	$426,202	$2,257,927
Average income per lamp	$3.80	$6.06

In selecting the 110 reports used as a basis for an average in 1907, ten reports were taken from each of the following states as fairly representative of the different sections of the United States: California, Illinois, Massachusetts, Missouri, New York, Ohio, Pennsylvania, Tennessee, Texas, Washington, and Wisconsin. Owing to the incomplete character of the data upon which the figures for 1907 are based, they should not be accepted as giving the exact price of lighting, but merely as showing that there is a general and unmistakable tendency toward a lower cost for electric lighting.

Stationary-motor service was second in importance as a source of income, and the states for which in 1907 an income of over $500,000 was reported are shown in Table 102.

Digitized by Google

TABLE 102.—*Commercial and municipal central electric stations—Gross income from stationary-motor service, for 14 selected states: 1907 and 1902.*

	STATIONARY-MOTOR SERVICE.	
	1907	1902
Total for United States	$28,511,550	$9,910,217
Total for 14 selected states	22,728,096	7,771,683
New York	5,688,401	2,396,046
California	3,826,462	1,228,099
Illinois	2,445,280	763,764
Pennsylvania	2,101,320	640,948
Massachusetts	1,519,708	744,879
Ohio	1,054,076	407,901
Missouri	985,596	402,937
Montana	963,669	32,881
Colorado	951,836	343,559
Michigan	873,081	173,881
New Jersey	682,028	258,055
Indiana	568,199	120,435
Minnesota	536,622	191,432
Washington	531,818	66,866
South Carolina	$432,384	$169,353
Connecticut	407,577	155,732
Texas	376,897	203,859
Oregon	375,306	89,942
Maryland	349,059	91,437
Maine	284,627	92,032
Iowa	261,202	78,180
Wisconsin	253,087	75,992
Kansas	224,224	48,558
Kentucky	220,061	92,401

Both for 1907 and 1902 the income from stationary-motor service for the 14 states shown in Table 102 was approximately four-fifths of the total for all states and territories, their proportion in 1907 being slightly greater than at the previous census. That New York, the leading state in population and in value of manufactures, with its great water power, should lead also in the income from stationary-motor service is not unexpected, but that California, which at the census of 1900 stood only twenty-first in population and twelfth in value of manufactures, should be easily second in income from this source is surprising, and shows that the use of electric current is more general in that state than elsewhere. It is worthy of mention that notwithstanding the large actual increase in the income from motor service for New York, that state's proportion of the total income for such service fell from 24.2 per cent in 1902 to 20 per cent in 1907; while that for California increased from 12.4 per cent to 13.4 per cent during the same time. The largest proportional increases in the income from motor service are those for Montana, which increased more than twenty-nine fold, and for Washington, which increased nearly eightfold.

Several states not mentioned in Table 102 show large increases in the income from motor service from 1902 to 1907. The figures for these states in the order of their importance are presented in the following tabular statement:

There appears to be no satisfactory way of ascertaining the average cost per kilowatt for motor service, since the conditions under which the income was obtained differed widely, not only as to the manner of charges, whether by meter, flat rate, or in bulk, but because of the variations in the length of service, and the certainty that the total kilowatts reported represent a large amount of idle or inactive dynamo capacity, while on the other hand many stations selling a large part of the electrical energy in bulk were unable to report the kilowatt capacity of the stationary motors used by the customers to whom the current was delivered. The capacity of the stationary motors both in 1907 and 1902 was reported in units of horsepower which, by being reduced to kilowatts, shows a total of 1,230,173 in 1907, and 326,752 in 1902. Using the figures as reported with their known failure to represent accurate totals, but assuming, for purposes of comparison, that the element of error was about equal at the two censuses, the average income per kilowatt capacity of stationary motors was less in 1907 than in 1902, the actual figures being $23.18 per kilowatt and $30.33 per kilowatt for the two censuses, respectively.

Next in order of importance to income from lighting and from stationary-motor service was the income from the sale of current to electric railways and to other electric companies. In Table 103 the income from all other electric service is classified into that from current sold to electric railways, that from current sold to other electric companies, and that from current sold for miscellaneous purposes, such as charging automobiles, operating fans, electric heating, cooking, welding, etc.

TABLE 103.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—GROSS INCOME FROM "ALL OTHER ELECTRIC SERVICE:" 1907 AND 1902.

SOURCE OF INCOME.	TOTAL.			COMMERCIAL.			MUNICIPAL.		
	1907	1902	Per cent of increase.	1907	1902	Per cent of increase.	1907	1902	Per cent of increase
Total	$15,348,027	$4,138,241	270.9	$15,290,229	$4,120,788	271.1	$57,798	$17,455	231.2
Current sold to electric railways	7,841,497	2,304,515	240.3	7,829,275	2,301,343	240.2	12,222	3,172	285.3
Current sold to other electric companies	5,519,746	1,727,112	219.6	5,513,302	1,723,427	219.9	6,444	3,685	74.9
Miscellaneous electric service	1,986,784	106,614	1,763.5	1,947,652	96,018	1,928.4	39,132	10,596	269.3

Digitized by Google

In 1907, of the total income from "All other electric service," 87.1 per cent was from current sold to electric-railway companies and to other electric companies as compared with 97.4 per cent in 1902. It appears, therefore, that notwithstanding the increase of 231.4 per cent in the total for such sales, the gain was proportionately less than that for the current sold for miscellaneous purposes. The income from this latter source increased from $106,614 in 1902 to $1,986,784 in 1907, or more than eighteenfold. More than two-thirds of this miscellaneous income was reported by stations in the state of New York, and most of it represented current sold for manufacturing purposes, much of which was sold to manufacturers using the electrolytic process. The continued cheapening of electric power and its growing popularity resulting from the wide range of uses to which it may be put, the ease with which it is made available, its cleanliness and convenience, and the quickness with which it may be applied or discontinued, together with its constantly increasing uses, indicate that the next census will show a greatly increased use of electrical energy for miscellaneous purposes.

Both in 1907 and in 1902 the proportion of the earnings from "All other electric service" derived from current sold to electric railways exceeded that from current sold to other electric companies.

The income from current sold to electric railways and to other electric companies is shown in Table 104 for the 12 states, each of which reported an income of more than $100,000 for the former character of service in 1907.

TABLE 104.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—GROSS INCOME FROM CURRENT SOLD TO ELECTRIC RAILWAYS AND TO OTHER ELECTRIC COMPANIES, FOR 12 SELECTED STATES: 1907 AND 1902.

	TOTAL.		INCOME FROM CURRENT SOLD TO ELECTRIC RAILWAYS.		INCOME FROM CURRENT SOLD TO OTHER ELECTRIC COMPANIES.	
	1907	1902	1907	1902	1907	1902
Total for United States	$13,361,243	$4,031,627	$7,841,497	$2,304,515	$5,519,746	$1,727,112
Total for 12 selected states	11,109,212	2,873,422	6,943,834	1,549,079	4,165,378	1,324,343
New York	2,748,057	1,356,819	1,168,700	389,829	1,579,357	966,990
California	1,946,894	430,602	1,396,735	183,986	550,159	246,616
Illinois	1,752,933	78,513	1,604,328	64,360	148,605	14,153
Pennsylvania	1,174,879	370,299	901,564	324,749	273,315	45,550
Michigan	958,753	63,661	277,115	55,830	681,638	7,831
Washington	607,980	99,600	143,183	86,588	464,797	13,012
Missouri	573,478	2,651	477,784	2,651	95,694	.....
Massachusetts	532,692	237,817	288,638	226,547	244,054	11,270
New Hampshire	290,971	75,684	217,361	71,586	73,610	4,098
Texas	187,276	106,043	187,276	91,220	.....	14,823
Oregon	179,518	51,000	167,072	51,000	12,446	.....
Indiana	155,781	733	114,078	733	41,703	.....

Of the total income for the two classes of service, 83.1 per cent in 1907 and 71.3 per cent in 1902 was contributed by the 12 states for which figures are shown in the table. In both years the income from current sold to electric railways exceeded that from current sold to other electric companies both for the United States and for the 12 states together. The 12 states increased their proportion of the total income from current sold to electric railways from 67.2 per cent in 1902 to 88.6 per cent in 1907; but the proportion of the total income from current sold to other electric companies reported by them declined from 76.7 per cent to 75.5 per cent. Several of the states—the most notable of which are Illinois, California, New York, Missouri, and Indiana—show remarkable gains in the income from current sold to electric railways, while Michigan and Washington show remarkable increases in the income from current sold to other electric companies.

Through the selection of states with reference to the income from the sale of current to electric railways, several were omitted which in 1907 reported an income of more than $100,000 from current sold to other electric companies, as follows: Georgia, $204,654; Utah, $203,587; Montana, $188,529; Colorado, $154,412; and Connecticut, $122,973.

An analysis of the income from miscellaneous service is given in Table 105.

TABLE 105.—*Commercial and municipal central electric stations—Income from electric service other than that for lighting, motor service, and current sold to railways and to other electric companies: 1907.*

KIND OF SERVICE.	Total.	Commercial.	Municipal.
Total	$1,986,784	$1,947,652	$39,132
Electric heating, cooking, welding, etc.	271,591	265,241	6,350
Charging automobiles	154,747	153,459	1,288
Running fans	197,736	172,746	24,990
Heating irons	17,636	14,451	3,185
Furnishing current for moving-picture shows	2,195	1,529	666
Charging batteries, motor boats, etc	696	696	.....
Furnishing current for signs	10,121	10,121	.....
Not specified	231,858	230,010	1,848
Other miscellaneous[1]	1,100,204	1,099,399	805

[1] A very small part of this amount was for current used to operate motors, but the income was mostly derived from current sold to electrolytic, electrochemical, or electrothermal plants for the production of aluminum, carborundum, carbide of calcium, caustic soda, etc.

Digitized by Google

The income from electric heating, cooking, welding, etc., and the income from charging automobiles were the only items in Table 105 which were specifically asked for in the schedule, and the remaining items represent a tabulation of amounts reported by companies which in answering the inquiry in reference to income from all other electric service specified the exact nature of the service. It is not believed that any of these items fully represents the actual earnings from the specific service. The introduction of the meter system of measuring the current used has, as before stated, tended to render it impracticable to distinguish between the use of current for lighting and for various other purposes in cases where the service is from the same wire and the total amount of electrical energy is recorded by the same meter.

EXPENSES.

The items of expense, the statistics for which are shown in the following tables, include salaries and wages of employees; supplies and materials used in connection with the operation of the plants; the cost of such supplies and materials as were sold and the proceeds reported under income; the cost of fuel; the amount expended for the purchase of power; and other miscellaneous expenses, which include such items as taxes, ordinary repairs to buildings and machinery, rent of stations, line-wire supports, insurance, injuries and damages, advertising, legal expenses, interest, and in fact all other expenses not elsewhere reported. It does not, however, include interest on bonds, as did the report for 1902.

The items of expense for the commercial and municipal stations are shown in Table 106.

The proportions of the total expenses reported by the two classes of stations show but little variation at the two censuses. In 1907 the commercial stations reported 91.4 per cent of the total, a decrease of one-tenth of 1 per cent from the corresponding proportion for 1902, while the municipal stations reported 8.6 per cent of the total. The percentages of increase were greater for the latter class of stations, except for power purchased and for rent and other miscellaneous expenses.

TABLE 106.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—EXPENSES: 1907 AND 1902.

	Census.	Total.	Commercial.	Municipal.	PER CENT OF TOTAL.		PER CENT OF INCREASE.		
					Commercial.	Municipal.	Total.	Commercial.	Municipal.
Number of stations	1907	4,714	3,462	1,252	73.4	26.6	30.2	23.4	53.6
	1902	3,620	2,805	815	77.5	22.5			
Total expenses	1907	$106,205,149	$97,037,961	$9,167,188	91.4	8.6	91.5	91.3	93.4
	1902	55,457,830	50,716,648	4,741,182	91.5	8.5			
Salaries and wages	1907	35,420,324	31,935,309	3,485,015	90.2	9.8	71.6	70.2	85.4
	1902	20,646,692	18,766,970	1,879,722	90.9	9.1			
Cost of supplies and materials	1907	14,326,351	12,969,731	1,356,620	90.5	9.5	56.6	56.3	59.1
	1902	9,149,664	8,296,763	852,901	90.7	9.3			
Cost of fuel	1907	23,057,745	19,824,962	3,232,783	86.0	14.0	98.2	94.6	123.6
	1902	11,635,509	10,189,685	1,445,824	87.6	12.4			
Power purchased	1907	7,074,472	6,696,188	378,284	94.7	5.3	232.0	233.6	206.1
	1902	2,130,759	2,007,193	123,566	94.2	5.8			
Miscellaneous expenses	1907	26,326,257	25,611,771	714,486	97.3	2.7	121.3	123.6	62.7
	1902	11,895,206	11,456,037	439,169	96.3	3.7			

The proportion that each item of expense bears to the total is shown in Table 107.

TABLE 107.—*Commercial and municipal central electric stations—Per cent that each item of expense is of total: 1907 and 1902.*

	TOTAL.		COMMERCIAL.		MUNICIPAL.	
	1907	1902	1907	1902	1907	1902
Total expenses	100.0	100.0	100.0	100.0	100.0	100.0
Salaries and wages	33.4	37.2	32.9	37.0	38.0	39.6
Cost of supplies and materials	13.5	16.5	13.4	16.4	14.8	18.0
Cost of fuel	21.7	21.0	20.4	20.1	35.3	30.5
Power purchased	6.7	3.8	6.9	4.0	4.1	2.6
Miscellaneous expenses	24.8	21.4	26.4	22.6	7.8	9.3

Table 107 shows that salaries and wages formed the largest proportion of the total expenses, being upward of one-third of the total at both censuses. Miscellaneous expenses, including rents, taxes, insurance, etc., was second in importance, forming nearly one-fourth of the total expenses in 1907 and more than one-fifth in 1902. The cost of fuel was of nearly equal importance with the last-mentioned item, and represented nearly the same proportion of the total at each of the two censuses. The cost of supplies and materials includes the amount expended during the year for such articles as meters, motors, transformers, lamps and fittings, poles or other supports, and wire and cable, etc., which were used in connection with the operation of the station or for ordinary repairs and replacements. It does not, however, include the cost of such of these articles as were used for new construction or for extension or additions to the plant or equipment. It also includes the cost of such of these articles as were sold, and the proceeds reported by the

Digitized by Google

company as an income, rent of water privileges for water wheels or turbines, and freight on material which was not included in the cost. The cost of power purchased was the least important class of expense, representing only 6.7 per cent of the total in 1907, but shows the largest proportionate increase of any of the items contained in the table.

The distribution of expenses between the purely electric and the composite stations is shown in Table 108.

TABLE 108.—PURELY ELECTRIC AND COMPOSITE CENTRAL ELECTRIC STATIONS—EXPENSES: 1907 AND 1902.

	Census.	Total.	Purely electric.	Composite.	PER CENT OF TOTAL.		PER CENT OF INCREASE.		
					Purely electric.	Composite.	Total.	Purely electric.	Composite.
Number of stations	1907	4,714	2,648	2,066	56.2	43.8	30.2	23.8	39.5
	1902	3,620	2,139	1,481	59.1	40.9			
Total expenses	1907	$106,205,149	$63,490,175	$42,714,974	59.8	40.2	91.5	70.3	134.9
	1902	55,457,830	37,272,578	18,185,252	67.2	32.8			
Salaries and wages	1907	35,420,324	20,914,204	14,506,120	59.0	41.0	71.6	50.6	114.7
	1902	20,646,692	13,891,426	6,755,266	67.3	32.7			
Cost of supplies and materials	1907	14,326,351	8,290,513	6,035,838	57.9	42.1	56.6	36.1	97.3
	1902	9,149,664	6,090,750	3,058,914	66.6	33.4			
Cost of fuel	1907	23,057,745	12,476,568	10,581,177	54.1	45.9	98.2	67.8	151.8
	1902	11,635,509	7,433,874	4,201,635	63.9	36.1			
Power purchased	1907	7,074,472	4,959,519	2,114,953	70.1	29.9	232.0	225.9	247.2
	1902	2,130,759	1,521,654	609,105	71.4	28.6			
Miscellaneous expenses	1907	26,326,257	16,849,371	9,476,886	64.0	36.0	121.3	102.1	166.2
	1902	11,895,206	8,334,874	3,560,332	70.1	29.9			

All the items of expense showed larger percentages of increase for the composite stations than for the purely electric stations, a condition similar to that which was shown in Table 85 for income. The proportion that the composite stations form of the total number was greater in 1907 than in 1902, but the proportion of the total expenses that was reported by this class showed a still larger increase. It is noteworthy that the composite stations show their smallest proportion of the total of the various items for power purchased. This is natural, as many of them owe their existence to the fact that there is a surplus of primary power from some other industry which is harnessed to a dynamo for the generation of electrical energy. For each item of expense the proportion chargeable to the purely electric stations was less in 1907 than in 1902.

The proportion that each item of expense is of the total for the purely electric and the composite central electric stations is shown in Table 109.

TABLE 109.—*Purely electric and composite central electric stations—Per cent that each item of expense is of total: 1907 and 1902.*

	TOTAL.		PURELY ELECTRIC.		COMPOSITE.	
	1907	1902	1907	1902	1907	1902
Total expenses	100.0	100.0	100.0	100.0	100.0	100.0
Salaries and wages	33.4	37.2	32.9	37.3	34.0	37.1
Cost of supplies and materials	13.5	16.5	13.1	16.3	14.1	16.8
Cost of fuel	21.7	21.0	19.7	19.9	24.8	23.1
Power purchased	6.7	3.8	7.8	4.1	5.0	3.3
Miscellaneous expenses	24.8	21.4	26.5	22.4	22.2	19.6

The proportion of the total expenses represented by salaries and wages, which formed about one-third of the total expenses for both the purely electric and the composite stations, and by the cost of supplies and materials, which formed rather more than one-eighth for each class, shows a decrease in 1907 as compared with 1902. The proportionate cost of fuel remained nearly constant for both classes of stations. For each of the two classes of stations miscellaneous expenses formed a greater proportion of the total expenses in 1907 than in 1902, the gain being the larger for the purely electric stations, for which it formed more than one-fourth of the total expenses in 1907. This latter class of stations also reported much the greater increase in the proportion represented by the cost of power purchased, which nearly doubled between 1902 and 1907.

The expenses of stations, classified according to the kind of primary power used and the percentages of increase, are shown in Tables 110 and 111.

Although the expenses of the stations operated by steam power exclusively show an increase of 74.6 per cent, the percentage of the total expenses reported for this class of stations shows a decrease of 6.8 in 1907 as compared with 1902. Only one other class of stations, those using gas exclusively, showed a diminution in its percentage of the total expenses at the later census as compared with the earlier. Although the expenses for this latter class of stations show an increase of 61.7 per cent, this was the smallest increase shown for any of the seven classes for which figures are given in Table 110. Each of the remaining classes of stations increased its proportion of the total expenses in 1907, and the stations using water with other minor power and the stations not equipped with primary power more than doubled their proportions. Of the total increase in the cost of power purchased, 56.9 per cent was contributed by the stations without primary power, which reported 53.2 per cent of the total cost of power in 1907 as compared with 44.5 per cent in 1902.

Digitized by Google

TABLE 110.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—EXPENSES, BY KIND OF PRIMARY POWER USED: 1907 AND 1902.

	Census.	Total.	Steam exclusively.	Steam with other minor power.	Water exclusively.	Water with other minor power.	Water and and steam.	Gas exclusively.	Stations without primary-power equipment.
Number of stations	1907	4,714	3,262	93	474	61	360	180	284
	1902	3,620	2,747	43	315	20	275	51	169
Total expenses	1907	$106,205,149	$74,178,650	$5,147,919	$4,972,066	$1,536,930	$12,234,923	$710,849	$7,423,812
	1902	55,457,830	42,492,368	2,228,828	2,448,675	342,327	5,675,249	439,650	1,830,733
Salaries and wages	1907	35,420,324	24,120,179	1,807,087	2,173,107	622,989	4,630,594	298,858	1,767,510
	1902	20,646,692	15,462,511	798,666	1,193,781	196,698	2,399,751	166,379	428,906
Cost of supplies and materials	1907	14,326,351	9,594,330	817,898	801,852	175,232	2,229,294	94,275	613,470
	1902	9,149,664	7,360,161	368,857	303,496	20,295	887,737	55,845	153,273
Cost of fuel	1907	23,057,745	19,480,534	1,377,563	26,844	184,569	1,716,574	192,835	78,826
	1902	11,635,509	10,126,800	596,019	5,511	7,602	832,601	60,520	6,456
Power purchased	1907	7,074,472	2,599,803	160,646	108,823	10,703	433,535	7,597	3,763,365
	1902	2,130,759	532,759	64,143	284,298	720	193,523	107,132	948,184
Miscellaneous expenses	1907	26,326,257	18,393,804	984,725	1,861,440	543,437	3,224,926	117,284	1,200,641
	1902	11,895,206	9,010,137	401,143	661,589	117,012	1,361,637	49,774	293,914

TABLE 111.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—PER CENT INCREASE OF EXPENSES, BY KIND OF PRIMARY POWER USED: 1907.

	Total.	Steam exclusively.	Steam with other minor power.	Water exclusively.	Water with other minor power.	Water and steam.	Gas exclusively.	Stations without primary-power equipment.
Number of stations	30.2	18.7	116.3	50.5	205.0	30.9	252.9	68.0
Total expenses	91.5	74.6	131.0	103.1	349.0	115.6	61.7	305.5
Salaries and wages	71.6	56.0	126.3	82.0	216.7	93.0	79.6	312.0
Cost of supplies and materials	56.6	30.4	121.7	164.2	763.4	151.1	68.8	312.1
Cost of fuel	98.2	92.4	131.1	387.1	2,327.9	106.2	218.6	1,121.0
Power purchased	232.0	386.1	150.4	[1] 61.7	1,386.5	124.0	[1] 92.9	296.9
Miscellaneous expenses	121.3	104.1	145.5	181.4	364.4	136.8	135.6	308.5

[1] Decrease.

For the separate items of expense the percentages of gains or losses vary so surprisingly that they can only be accounted for by a transfer of stations from one group to another by reason of changes in or addition to their primary power. There is no doubt that many changes of this character have taken place since 1902, as a result of which stations reported in one class at that census are shown in another class in 1907; and the totals, therefore, in Table 110, although showing existing conditions at each census, may not correctly portray the increase in the sense in which this term is generally applied.

The percentages which the several items of expense form of the total for each class of stations are shown in Table 112.

TABLE 112.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—PER CENT DISTRIBUTION OF TOTAL EXPENSES FOR EACH KIND OF POWER USED, BY ITEMS OF EXPENSE: 1907 AND 1902.

	Census.	Total.	Steam exclusively.	Steam with other minor power.	Water exclusively.	Water with other minor power.	Water and steam.	Gas exclusively	Stations without primary-power equipment.
Total expenses	1907	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	1902	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Salaries and wages	1907	33.4	32.5	35.1	43.7	40.5	37.8	42.0	23.8
	1902	37.2	36.4	35.8	48.8	57.5	42.3	37.8	23.4
Cost of supplies and materials	1907	13.5	12.9	15.9	16.1	11.4	18.2	13.3	8.3
	1902	16.5	17.3	16.5	12.4	5.9	15.6	12.7	8.4
Cost of fuel	1907	21.7	26.3	26.8	0.5	12.0	14.0	27.1	1.1
	1902	21.0	23.8	26.7	0.2	2.2	14.7	13.8	0.4
Power purchased	1907	6.7	3.5	3.1	2.2	0.7	3.5	1.1	50.7
	1902	3.8	1.3	2.9	11.6	0.2	3.4	24.4	51.8
Miscellaneous expenses	1907	24.8	24.8	19.1	37.4	35.4	26.4	16.5	16.2
	1902	21.4	21.2	18.0	27.0	34.2	24.0	11.3	16.1

Digitized by Google

Salaries and wages forms the largest item of expense for each class of stations equipped with primary power. That the stations having steam as the exclusive primary power showed the smallest proportionate expense for salaries and wages, is due in a measure to the fact that the cost of fuel forms a large item of expense for these stations, in addition to which this class includes a large proportion of the municipal stations for which the expense for salaries and wages is small. The percentage represented by cost of supplies and materials is reasonably uniform for the classes having primary power. Naturally, the stations having steam power show the largest proportionate cost of fuel. That the stations using water power exclusively and those classed as without primary power report fuel, may be explained by the fact that a number of stations which had been operated by steam in the early part of the year had removed their steam equipment and were operated by water power or wholly discontinued the use of primary power at the close of the year, the date for which the stations are classified as to kind of power and in other respects. The per cent distribution of expenses for the stations without primary power is scarcely comparable with those for the other classes of stations. About half the cost of operation of these stations lay in power purchased.

Salaries and wages.—The employees whose remuneration figures in the expense tables of this report include all those engaged in operating the plant and keeping the equipment in proper condition. The number and the salaries and wages of employees engaged exclusively upon new work or additions and extensions are not included, since this expense is reported as part of the cost of construction during the year. If, however, any of the regular employees of the station who are ordinarily engaged in the operation of the plant were engaged a part of the time on new construction or additions, the amount paid such employees was included under "Salaries and wages." If rent, board, or other allowance was furnished as part compensation it was included in the total for salaries and wages. In the case of composite stations it frequently happens that such employees as general managers, clerks, engineers, and firemen work indiscriminately for the electric station and for the gas works or waterworks, etc., and in these instances an estimate was made of the proportion of salaries and wages chargeable to the electric service. No attempt has been made in this report to show the average wages of employees. One of the reasons for this is that a number of stations were in operation only a part of the year; and since these stations would show the full normal number of employees but wages for only that part of the year for which they were employed, the average wage as determined by dividing the total wages paid during the year by the average number of employees would produce results considerably less than the facts would warrant. The figures given for the average number of wage-earners represented approximately the number necessary to conduct the plant under normal conditions, or the average calculated from the weekly pay rolls of the company.

Detailed statistics of salaries and wages are presented in Table 113.

TABLE 113.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—EMPLOYEES, SALARIES, AND WAGES: 1907 AND 1902.

	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.			PER CENT OF TOTAL.			
										Commercial.		Municipal.	
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.	1907	1902	1907	1902
Total:													
Number	47,632	30,326	42,066	26,909	5,566	3,417	57.1	56.3	62.9	88.3	88.7	11.7	11.3
Salaries and wages	$35,420,324	$20,646,692	$31,935,309	$18,766,970	$3,485,015	$1,879,722	71.6	70.2	85.4	90.2	90.9	9.8	9.1
Salaried employees:													
General officers of corporations—													
Number	1,761	1,416	1,761	1,416	.....	.....	24.4	24.4	.....	100.0	100.0	.....	.....
Salaries	$2,202,028	$1,465,471	$2,202,028	$1,465,471	.....	.....	50.3	50.3	.....	100.0	100 0	.....	.....
General managers, superintendents, etc.—													
Number	4,357	2,564	3,268	1,875	1,089	689	69.9	74.3	58.1	75.0	73.1	25.0	26.9
Salaries	$5,058,236	$2,481,278	$4,243,307	$2,088,298	$814,929	$392,980	103.9	103.2	107.4	83.9	84.2	16.1	15.8
Clerks and bookkeepers—													
Number	6,872	3,016	6,346	2,755	526	261	127.9	130.3	101.5	92.3	91.3	7.7	8.7
Salaries	$4,473,523	$1,716,831	$4,293,620	$1,652,430	$179,903	$64,401	160.6	159.8	179.3	96.0	96.2	4.0	3.8
Wage-earners:													
Foremen—													
Average number	1,434	1,000	1,344	943	90	57	43.4	42.5	57.9	93.7	94.3	6.3	5.7
Wages	$1,527,494	$953,738	$1,446,048	$910,972	$81,446	$42,766	60.2	58.7	90.4	94.7	95.5	5.3	4.5
Inspectors—													
Average number	894	571	860	546	34	25	56.6	57.5	36.0	96.2	95.6	3.8	4.4
Wages	$697,097	$415,904	$668,465	$397,983	$28,632	$17,921	67.6	68.0	59.8	95.9	95.7	4.1	4.3
Engineers—													
Average number	5,857	4,587	4,446	3,743	1,411	844	27.7	18.8	67.2	75.9	81.6	24.1	18.4
Wages	$4,453,378	$3,259,870	$3,484,231	$2,721,127	$969,147	$538,743	36.6	28.0	79.9	78.2	83.5	21.8	16.5
All other—													
Average number	26,457	17,172	24,041	15,631	2,416	1,541	54.1	53.8	56.8	90.9	91.0	9.1	9.0
Wages	$17,008,568	$10,353,600	$15,597,610	$9,530,689	$1,410,958	$822,911	64.3	63.7	71.5	91.7	92.1	8.3	7.9

Digitized by Google

Table 113 shows that of the total number of employees of electric light and power stations in 1907, the municipal stations employed 11.7 per cent. For the same year the proportion of the gross income reported by this class of stations, as given in Table 83, was 8 per cent. Thus the number of employees of the municipal stations is greater in proportion to their income than in the case of the commercial stations. This does not hold for all classes of employees, but is conspicuously true for general managers, superintendents, etc., among the salaried employees, and for the engineers among the wage-earners. The large number of the latter class is probably due to the fact that in the small stations which so largely predominate in the municipal stations the same employee often performs a number of different kinds of work, and the man, among his other duties, might have operated the engine, and hence would be reported as an engineer.

A comparison of the number of employees and their earnings in 1902 and 1907 shows a greater relative increase in the case of the municipal than in that of the commercial stations, although the actual increases for the commercial and for the municipal stations should be considered in connection with this statement.

The commercial stations reported approximately seven-eighths of the total number of employees in 1907 and about nine-tenths of the total amount expended for salaries and wages. This appears to indicate that in general the commercial stations pay their employees more liberally than do the municipal stations. This difference holds for both salaried employees and wage-earners, but is most marked in the case of the former. In 1907 the commercial stations reported 87.6 per cent of the total salaried employees and 91.5 per cent of the total salaries. There are two reasons for this difference. In the first place there are connected with the municipal stations no corporation officials who, in the commercial stations, receive the highest salaries of any of the employees. And secondly, many municipal stations reported salaried employees whose time was partly given to other public utilities of the municipality, and only a portion of whose salaries was charged to the operation of the electric station. Similar conditions are, to a greater or less extent, applicable to the wage-earners of the municipal stations, since many of them give part of their time only to the work of the electric plant.

Supplies and materials.—Details of the cost of supplies and materials, together with the cost of power purchased, are shown in Table 114.

TABLE 114.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—COST OF SUPPLIES AND MATERIALS: 1907 AND 1902.

	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.			PER CENT OF TOTAL.			
										Commercial.		Municipal.	
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.	1907	1902	1907	1902
Total cost	$21,400,823	$11,280,423	$19,665,919	$10,303,956	$1,734,904	$976,467	89.7	90.9	77.7	91.9	91.3	8.1	8.7
Meters:													
Number	31,900	27,632	28,024	25,739	3,876	1,893	15.4	8.9	104.8	87.8	93.1	12.2	6.9
Cost	$426,625	$416,994	$378,432	$390,569	$48,193	$26,425	2.3	[1]3.1	82.4	88.7	93.7	11.3	6.3
Motors:													
Number	4,646	602	4,522	572	124	30	671.8	690.6	313.3	97.3	95.0	2.7	5.0
Cost	$278,410	$30,099	$270,661	$29,202	$7,749	$897	825.0	826.9	763.9	97.2	97.0	2.8	3.0
Transformers:													
Number	6,762	13,288	5,468	7,843	1,294	5,445	[1]49.1	[1]30.3	[1]76.2	80.9	59.0	19.1	41.0
Cost	$337,706	$365,028	$288,586	$326,407	$49,120	$38,621	[1]7.5	[1]11.6	27.2	85.5	89.4	14.5	10.6
Incandescent lamps	$3,191,252	$1,507,249	$3,042,738	$1,426,224	$148,514	$81,025	111.7	113.3	83.3	95.3	94.6	4.7	5.4
Lamp fittings, etc. (except for arc lamps)	$762,593	$177,236	$676,339	$154,517	$86,254	$22,719	330.3	337.7	279.7	88.7	87.2	11.3	12.8
Carbons, globes, hoods, and other supplies for arc lamps and repairs	$1,698,205	$1,466,852	$1,456,927	$1,263,528	$241,278	$203,324	15.8	15.3	18.7	85.8	86.1	14.2	13.9
Poles and other supports	$757,379	$346,587	$701,081	$319,617	$56,298	$26,970	118.5	119.4	108.7	92.6	92.2	7.4	7.8
Wire and cable	$1,769,109	$1,152,915	$1,623,078	$1,081,380	$146,031	$71,535	53.4	50.1	104.1	91.7	93.8	8.3	6.2
Power purchased	$7,074,472	$2,130,759	$6,696,188	$2,007,193	$378,284	$123,566	232.0	233.6	206.2	94.7	94.2	5.3	5.8
Rent of water privileges for water wheels or turbines	$386,552	[2]	$351,443	[2]	$35,109	[2]				90.9		9.1	
All other materials	$4,436,728	$2,566,341	$3,993,181	$2,365,807	$443,547	$200,534	72.9	68.8	121.2	90.0	92.2	10.0	7.8
Freight, not included in cost of materials	$281,792	$1,120,363	$187,265	$939,512	$94,527	$180,851	[1]74.8	[1]80.1	[1]47.7	66.5	83.9	33.5	16.1

[1] Decrease.

[2] Not reported separately in 1902.

The total cost of supplies, materials, etc., shows a somewhat larger percentage of increase than do salaries and wages, and the commercial stations show a larger per cent of increase in the total cost of supplies and materials than do the municipal stations. The commercial stations reported a smaller amount as paid for meters and transformers in 1907 than in 1902. The amounts reported for these two items at the two censuses are of doubtful value for purposes of comparison, because of the uncertainty as to whether

Digitized by Google

the questions were answered with the same understanding as to their meaning. In connection with the canvass of 1907 it was found that many stations had included, under supplies and materials, the cost of meters and transformers that had been used in connection with new work and which should have been reported under the cost of construction during the year. In 1902, when the first census of electric stations was taken, errors of this kind may have been overlooked, for it seems improbable that, in view of the increased use of meters and the general replacement of small and worn-out transformers by larger and better ones, the total cost of these machines, which could properly be classed as "Cost of supplies and materials," should be less in 1907 than 1902.

For purposes of comparison the amounts reported as paid for freight in 1907 and 1902 are of no value, because of the fact that some stations keep a separate account of freight charges and others reckon these charges in with the cost of supplies received. Thus the amounts reported are simply such part of the total freight charges as were kept separate from the cost of supplies and materials.

Of all the different items included under expenditures for supplies and materials, the cost of motors shows the largest percentage of increase. The amount paid for incandescent lamps more than doubled, and the amount paid for fittings for lamps of this character shows a still larger percentage of increase. The amount paid for carbons, globes, etc., for arc lamps was but little more in 1907 than in 1902.

Fuel.—The cost of fuel, which is reported as a single item in the foregoing tables of this report, is shown in detail in Table 115.

TABLE 115.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—COST OF FUEL: 1907 AND 1902.

	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.			PER CENT OF TOTAL.			
										Commercial.		Municipal.	
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.	1907	1902	1907	1902
Total	$23,057,745	$11,635,509	$19,824,962	$10,189,685	$3,232,783	$1,445,824	98.2	94.6	123.6	86.0	87.6	14.0	12.4
Coal	19,681,212	9,943,125	16,780,874	8,749,394	2,900,338	1,193,731	97.9	91.8	143.0	85.3	88.0	14.7	12.0
Crude petroleum	2,171,547	721,838	2,043,000	700,136	128,547	21,702	200.8	191.8	492.3	94.1	97.0	5.9	3.0
Natural gas	299,648	254,269	259,181	220,460	40,467	33,809	17.8	17.6	19.7	86.5	86.7	13.5	13.3
Manufactured gas	194,816	28,654	194,816	20,135	.....	8,519	579.9	867.5	.....	100.0	70.3	.....	29.7
All other fuel	710,522	687,623	547,091	499,560	163,431	188,063	3.3	9.5	[1] 13.1	77.0	72.7	23.0	27.3

[1] Decrease.

Both in 1902 and 1907 approximately seventeen-twentieths of the total cost of fuel reported represented the cost of coal. Crude petroleum was next in importance, the percentage which the cost of this fuel represented of the total cost increasing from 6.2 in 1902 to 9.4 in 1907. The cost of the three remaining classes of fuel shown formed but 5.2 per cent of the total cost of fuel in 1907 as compared with 8.3 per cent in 1902.

All of the amount paid in 1907 for manufactured gas was reported by the commercial stations, but for natural gas the proportion of the total represented by each of the two classes of stations at the two censuses varied but little from the proportions shown for coal. The use of crude petroleum appears to have been chiefly confined to the commercial stations, which reported 94.1 per cent of the total cost of this kind of fuel reported in 1907 and 97 per cent in 1902.

The states in which the central stations reported an expenditure for coal amounting to more than $1,000,000 were as follows: New York, $2,980,946; Illinois, $1,997,418; Pennsylvania, $1,899,829; Massachusetts, $1,344,354; and Ohio, $1,215,778. The states in which the stations reported more than $100,000 as spent for crude petroleum were: California, $945,251; Texas, $728,343; and Arizona, $167,922. Among the largest users of natural gas, with the amount spent for this fuel in 1907, were: Ohio, $83,979; Pennsylvania, $67,923; Kansas, $52,424; Oklahoma, $29,557; and West Virginia, $29,401. No large amount was reported by any state as spent for manufactured gas, except by California, the stations in which state reported $150,407 or 77.2 per cent of the total amount reported for this class of fuel. Expenditures for "All other fuel," while general among the stations in the various states, were largest in those states having an abundance of timber.

Power purchased.—This constitutes the smallest of the several items of expense shown in Table 106, but shows the largest rate of increase, 232 per cent. Expenditures for electric current naturally form the greater part of this item, amounting to $6,417,237 in 1907 and $1,300,925 in 1902, a gain of $5,116,312, or 393.3 per cent. The expenditure for other power—steam, water, etc.—amounted to $657,235 in 1907 as compared with $829,834 in 1902. Although the reported expenditure for other power was less in 1907 than in 1902, it is probable that there was no actual decrease, since the amount for 1902 included the cost of water for water wheels and turbines, which was, in 1907, not included with the cost of power purchased, and which amounted in that year to $386,552.

The following states reported the largest amounts for power purchased in 1907: New York, $2,105,944;

Digitized by Google

Pennsylvania, $744,378; California, $693,953; Michigan, $630,532; Washington, $365,111; Missouri, $337,859; Massachusetts, $295,442; and Illinois, $263,848.

In 1907 there were 414 stations which reported the purchase of power as compared with 128 in 1902. Of the number reporting in 1907, 165 both generated and purchased current, and of the number reporting in 1902, 41 did the same. Moreover, a number of stations were found which, though fitted with dynamos, did not operate them, but purchased the current used. In 1907 there were 26 stations of this character, with a dynamo capacity of 15,688 kilowatts, as compared with 15 stations in 1902, with a dynamo capacity of 5,035 kilowatts.

Miscellaneous expenses.—Details of the expenses included in the last item of Table 106 are shown for the commercial and municipal stations in Table 116.

TABLE 116.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—MISCELLANEOUS EXPENSES: 1907 AND 1902.

	TOTAL.		COMMERCIAL.		MUNICIPAL.		PER CENT OF INCREASE.			PER CENT OF TOTAL.			
										Commercial.		Municipal.	
	1907	1902	1907	1902	1907	1902	Total.	Commercial.	Municipal.	1907	1902	1907	1902
Total	$26,326,257	$11,895,206	$25,611,771	$11,456,037	$714,486	$439,169	121.3	123.6	62.7	97.3	96.3	2.7	3.7
Rent of stations, line-wire supports, conduits, etc.	2,322,753	1,011,691	2,317,099	1,001,504	5,654	10,187	129.6	131.4	[1]44.5	99.8	99.0	0.2	1.0
Rent of offices	577,193	275,007	566,472	270,446	10,721	4,561	109.9	109.5	135.1	98.1	98.3	1.9	1.7
Taxes	6,351,020	2,665,005	6,345,796	2,654,885	5,224	10,120	138.3	139.0	[1]48.4	99.9	99.6	0.1	0.4
Injuries and damages	634,991	248,304	602,523	246,545	32,468	1,759	155.7	144.4	1,745.8	94.9	99.3	5.1	0.7
Insurance	1,578,205	893,567	1,467,936	827,926	110,269	65,641	76.6	77.3	68.0	93.0	92.7	7.0	7.3
Ordinary repairs of buildings and machinery	4,300,684	2,701,747	3,986,586	2,480,217	314,098	221,530	59.2	60.7	41.8	92.7	91.8	7.3	8.2
All other expenses not elsewhere reported	10,561,411	4,099,885	10,325,359	3,974,514	236,052	125,371	157.6	159.8	88.3	97.8	96.9	2.2	3.1

[1] Decrease.

More than nineteen-twentieths of the total for these miscellaneous expenses was reported by the commercial stations and less than one-twentieth by the municipal stations. Of the expense for ordinary repairs of buildings and machinery and for insurance, the proportions for the two classes of stations were practically the same in 1907 as in 1902, or more than nine-tenths for the commercial stations and less than one-tenth for the municipal. Expenditures for ordinary repairs are common to the two classes of stations, though necessarily varying in proportion to the age and condition of the plant and the standard to which it is kept up. The proportion of "All other expenses not elsewhere reported," paid by the municipal stations was relatively small, as might be expected, since these stations have much less occasion for expenditures for many of the items included under this head, such as advertising, interest, law expenses, etc., than have the commercial stations. The municipal stations also reported relatively insignificant amounts as paid for the rent of stations, line-wire supports, etc., office rents, and for taxes.

Digitized by Google

CHAPTER VIII.

TECHNICAL ASPECTS OF THE PERIOD.

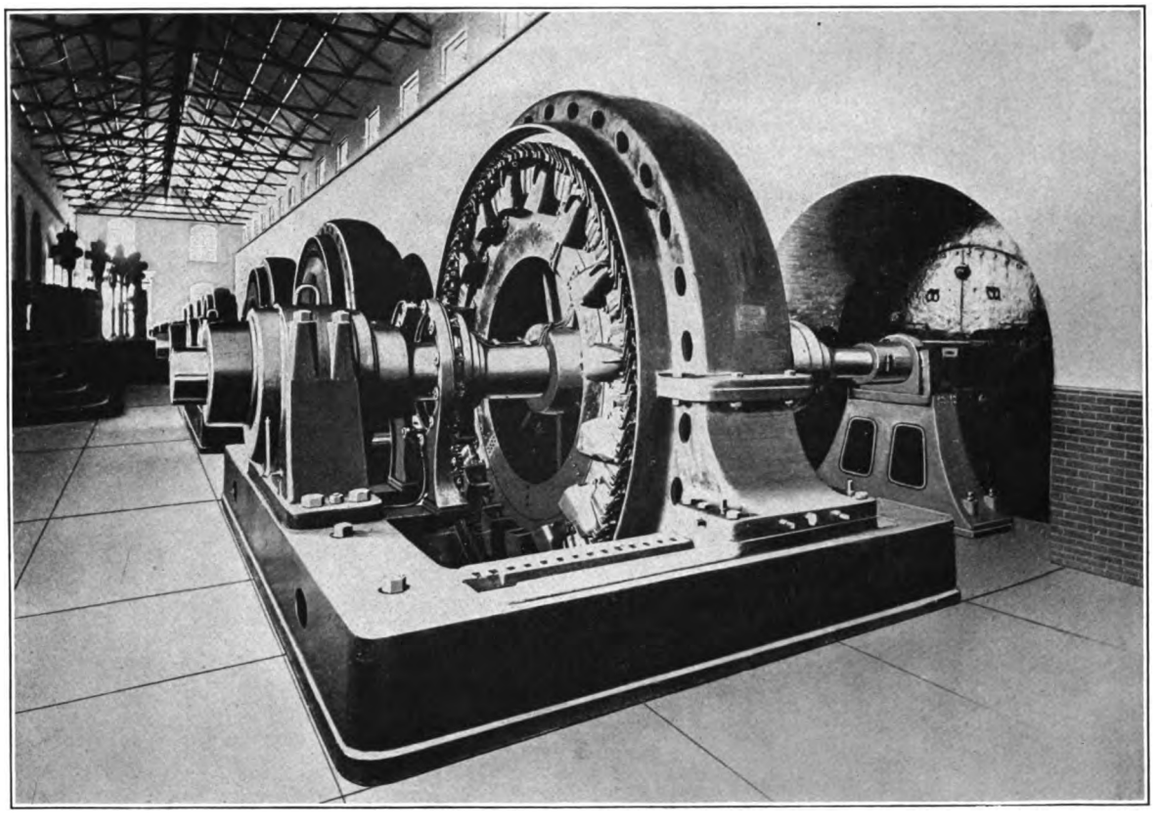
By THOMAS COMMERFORD MARTIN, Expert Special Agent.

General conditions.—The report on central electric light and power stations for 1902 embraced a historical review of their development and discussed the apparatus in use at that time for the generation of electrical energy and for its distribution and consumption, including dynamos, motors, transformers, arc and incandescent lamps, and other appliances. It is not necessary, therefore, to consider again these phases in the growth of the electric light and power industry; and the present discussion will be limited to the evolution that has taken place since 1902. There have been changes in every branch of the industry, some of which have been extreme, and the approach of a few of which was indicated in the former report. In one or two instances the introduction of new methods or appliances was unexpected. The changes in the technical aspects of the industry have kept pace with those in its financial and physical aspects. Virtually doubling itself every five years, in the latter respects, the central-station industry displays as yet no symptoms of settling down into a condition of satisfaction with the present which would be obstructive of improvement. Indeed, the notable tendency toward the consolidation of small individual stations into large "systems" with extensive networks has brought with it the wholesale "scrapping" of plants and apparatus and the installation of generating and consuming appliances of far higher efficiency and economy, in order to meet the demand on the part of the public for cheaper and better service.

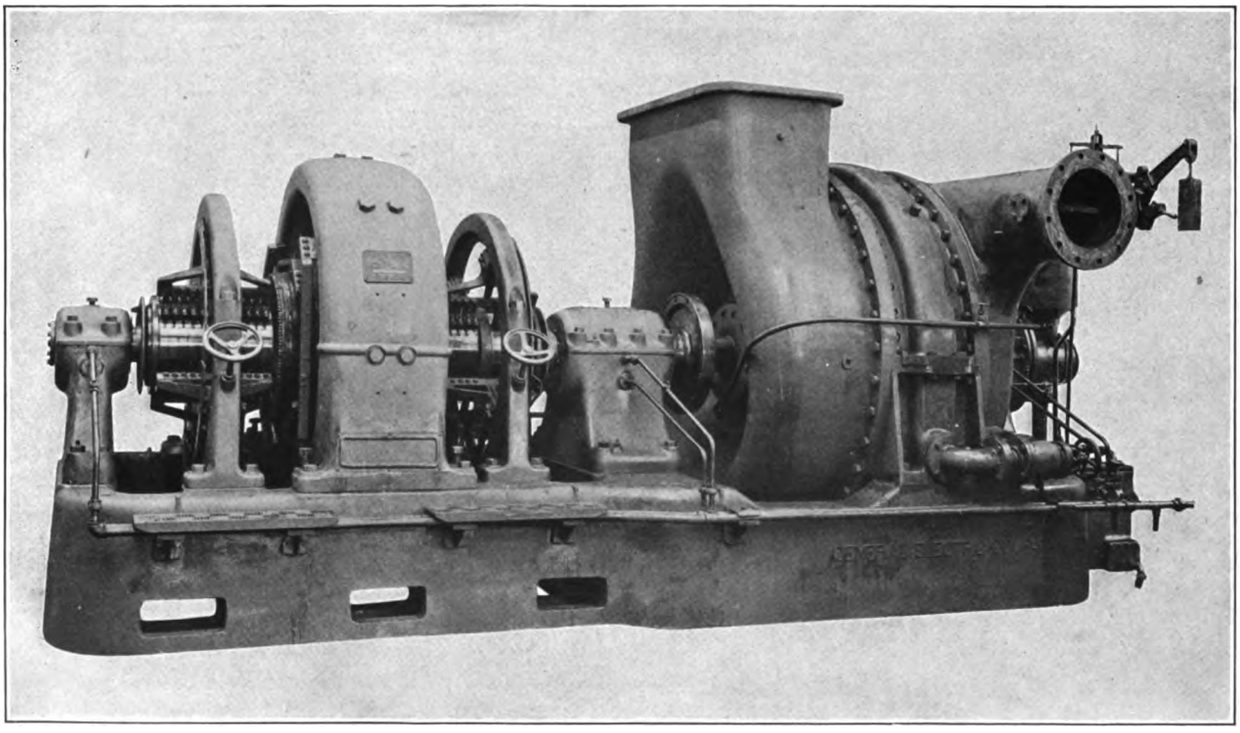
A typical case is that of the Boston Edison Company, whose system in 1885 covered an area of one-eighth of a square mile, and at present covers an area of 509 square miles—the increase being due chiefly to expansion during the period 1902–1907. The map presented herewith, showing some of its circuits, reveals the details of that vastly larger area in which it is now operating, within which lie 35 cities and towns of Massachusetts, with a combined population of approximately 1,000,000 inhabitants. Included in this territory are 2,197 miles of streets, 1,016 miles of which are covered by the lines of the company Within the region are 34,428 customers, requiring a supply of current up to 100,000 kilowatts, equivalent to two million 16-candlepower lamps. Originally the engines in the generating plant were of 90 horsepower, but they have been displaced by steam turbines of 16,000 horsepower each; while generators of 20-kilowatt capacity have been succeeded by generators of 12,000-kilowatt capacity. All this development has taken place within a period of about twenty-five years, and similar development is shown in other large centers of population, such as those served by the Public Service Corporation in New Jersey and the Pacific Gas and Electric Company in California.

Another salient feature of the period 1902–1907 is the increasing resort to water power as a source of primary energy. The statistics in Chapter III on power equipment show that the number of steam engines, including steam turbines, in central stations increased from 5,930 in 1902, with a total of 1,379,941 horsepower, to 7,206 in 1907, with 2,627,450 horsepower. Practically all these engines were located within the corporate limits of towns and cities, and the increase in capacity during the five-year period was nearly 100 per cent. But the development in water power due to the establishment of perhaps not less than 300 hydro-electric power transmission enterprises is much more striking. The water wheels reported show an increase from 1,390 in 1902 to 2,481 in 1907, while their capacity increased from 438,472 horsepower to 1,349,-087 horsepower, more than threefold. It is not to be understood that all this hydro-electric power is specifically employed in central station lighting and power, as a great deal of it is furnished to electric railways and isolated mills and mines. But the power-transmission company is generically a central-station plant, and all such companies and systems are included in the present statistics where they affect the totals and the analytic deductions in many important respects, as, for example, in the average price obtained per kilowatt hour. It is obvious, upon a moment's consideration, that a transmission company can sell its product at a lower rate than a central station which in its price per kilowatt hour to the customer has to include free supply of lamps, or arc carbons and globes, labor, inspection, etc. The apparent return per kilowatt hour as given in this report is thus too low, from the central-station standpoint, and would naturally be higher after the deduction of a very large but inde-

Digitized by Google



INTERIOR VIEW OF SOUTHERN POWER COMPANY'S HYDRO-ELECTRIC PLANT.



HORIZONTAL LOW-PRESSURE STEAM TURBINE AND GENERATOR.

Digitized by Google

Digitized by Google

terminate quantity of electrical energy sold in bulk by the power company, almost invariably at a price below what the same power would cost the receiving central-station company, or individual consumer, if it were produced by steam at or near the point of utilization.

This development of remote water powers for purposes of electrical transmission is recognized as one of the questions of the time, and was given special study by the conservation conference held at the White House in 1908, on invitation of President Roosevelt. In a report [1] to this conference, made by Mr. H. St. Clair Putnam, it was stated that of the total estimated power produced in the United States in 1907, about 26,000,000 horsepower was credited to steam engines, 800,000 horsepower to gas and oil engines, and 3,000,000 horsepower to water motors. It will be seen from these figures that nearly half the utilized water power of the country is subject to central-station conditions and control, and the proportion belonging to hydro-electric power is in reality much larger, as several hundred small electric plants not engaged in the sale of electricity, but connected with various manufactories, employ water power. Mr. Putnam said:

> During the past few years there has been renewed interest in water powers on account of the practicability of their use for the generation of power and the electrical transmission of this power to distant markets. The great hydro-electric development at Niagara was the first large enterprise of this character and has demonstrated its practicability. The census of 1902 gives a partial list of long-distance hydro-electric plants developing power aggregating 600,000 horsepower; and this list can now be largely increased. Our most desirable water powers are being absorbed rapidly, and it becomes important, therefore, for us to take stock of our water resources and formulate plans for their control and proper utilization.

The recognition of the importance of water-power development has grown since the conference was held, and the proper methods of dealing with water powers and maintaining public control and interest in them have become a distinct problem for the National Government, as well as one of the topics most agitated in the press.

Steam power.—The figures in Chapter III show striking changes in the use of steam power in central stations since the report of 1902. At that time, owing to the fact that steam turbines had not been installed in any considerable degree, they were not reported separately. In the present report they are credited with 19.9 per cent of the total horsepower reported and 31.1 per cent of all the steam power. Few revolutions in the mechanical world have been more rapid and sweeping. The relative size of the units is also significant, for while the reciprocating engines averaged 265 horsepower in 1907, the turbines averaged 2,168 horsepower, or eight times as much.

[1] Proceedings of a Conference of Governors, published by authority of Congress, 1909, p. 292.

Only one or two of the recently equipped central stations with large generating units have installed reciprocating engines. The most notable instance is the Redondo generating station of the Pacific Light and Power Company of California, which has been equipped with reciprocating engines of the latest type. The plant has a nominal rating of 15,000 kilowatts in three equal units, which generate current at the extremely high electro-motive force of 18,000 volts, for which the dynamos are wound. There are three 34 and 70 inch by 56 inch combined double horizontal and vertical compound side-crank automatic engines, each direct-connected to one of the 50-cycle 3-phase alternators of the fly-wheel type. The fuel used is crude petroleum. On a total output of not less than 60,000 kilowatt hours per 19.5 hours running for fifteen days, there being 4.5 hours of "stand-by" idleness each day, the contractor guaranteed an output of 170 kilowatt hours per barrel of oil weighing 334 pounds, each pound delivering 18,500 British thermal units. The actual test showed 252.8 kilowatt hours per barrel; and a bonus of $363,310 was earned by the contractor as a result of this remarkable economy and efficiency. It is stated that the first cost of the plant did not exceed by 5 per cent that of a steam-turbine plant.

No other large new central station with reciprocating engines can be named. The whole drift seems to be toward large steam turbines or large gas engines, where water power is not available, or even as a reserve where the uncertainty of water power renders some auxiliary power necessary. Chicago and New York have both furnished examples. The New York Edison Company now has both its great Waterside stations in operation side by side on the East River, with an aggregate maximum rating of 330,000 horsepower, in 24 units of 169,500 kilowatts. Waterside No. 2 began operations in November, 1906, and although reciprocating units were first contemplated, it now contains six 8,000-kilowatt vertical turbo-generators, two 7,500-kilowatt horizontal turbine units, and two 14,000-kilowatt vertical units, which comprise the entire equipment of this huge station. Waterside No. 1, which began operations in October, 1901, and was intended to hold sixteen 3,500-kilowatt reciprocating engine units, has now eleven such units, together with three 10,000-kilowatt and two 5,000-kilowatt vertical turbine units.

The new Quarry Street station of the Commonwealth Edison Company of Chicago, constructed just across the south branch of the Chicago River from the Fisk Street station, illustrated in the report of 1902, constitutes, with its initial rating of 28,000 kilowatts in two units, a fit supplement to the latter station, the pioneer great steam turbine power house in this country. It is significant of the rapid march of events that the first four turbo-generators in the Fisk Street station, only five years old, were replaced in the summer of 1909 by an equal number of 12,000-

Digitized by Google

kilowatt units, which change increases the Fisk Street station rating by 22,000 kilowatts without any addition in the boiler room except the extension of two stacks and slightly increased grate surface.

A further development in the use of primary power has been the practice in high-pressure steam generating plants to resort to low-pressure steam turbines which run on the exhaust steam of reciprocating engines, and this practice appears to have been quite successful. In a paper on the subject[1] read at Atlantic City in June, 1909, before the National Electric Light Association, Mr. C. H. Smoot cited several instances, and said: "I strongly suggest that owners of noncondensing plants consider the opportunity of utilizing the exhaust of their reciprocating engines in low-pressure steam turbines, and thereby adopt a method of rejuvenating their plants by one of the most efficient methods of developing power from steam."

Oil engines.—The Pittsfield (Mass.) Electric Company has put in regular service an interesting oil-driven plant to supplement its older steam plant, which also does a large exhaust-steam heating business in the cold season. The fuel used is crude petroleum. A side track of the Boston and Albany Railroad extends parallel to the north wall of the station, and all the fuel oil is handled upon this spur. Oil is stored outside the plant in three 6,000-gallon tanks. These tanks are filled by gravity from the oil cars run upon the siding, and from the tanks the oil is piped into the basement of the power house. Water for cooling the jackets and bearings of the machinery in the station is drawn from a neighboring pond through an 18-inch pipe, which terminates in a well about 60 feet inland from the shore. From the well a triplex pump in the basement draws and delivers the water as needed in the plant.

The generating unit is a 350-kilowatt, 60-cycle, 2,300-volt, 2-phase revolving-field alternator mounted on a shaft midway between two 16-inch by 24-inch 3-cylinder oil engines. The normal speed of this unit is 164 revolutions per minute. It is governed by by-passing the oil supply back into the suction side of the oil pump. In general design and appearance the engine follows the lines of a vertical inclosed type of steam engine. The action is on the 4-stroke cycle, but the engine differs from all previous internal-combustion engines in compressing a full charge of air to a point above the igniting point of the fuel, whether liquid or gaseous, and then injecting this fuel for a certain period, variable according to the load, into this red-hot air, where it burns under controlled limits of temperature and pressure. The cylinder operation is therefore one of combustion rather than explosion. Each engine is rated at 225 horsepower, weighs 80,000 pounds, and has the following over-all dimensions: Floor space, 9 feet 6 inches by 16 feet 6 inches; height, 12 feet. Foundation dimensions: Width of top, 10 feet; bottom, 12 feet; length, 20 feet; height, 7 feet, 1 inch. The latter dimensions include the space required by a direct-connected engine-type generator.

Gas engines.—A notable development in the generation of current has been the resort in San Francisco to very large gas engines by the California Gas and Electric Corporation. Its three engines, each of 5,333 horsepower, connected to the alternating-current generators, have the following dimensions: Length over all, 70 feet; width over all, 34 feet; weight of heaviest casting, 60 tons; diameters of cylinders, 42 inches; length of stroke, 60 inches; main journals, 30 inches diameter, 54 inches long; main crosshead gibs, 27 inches wide, 54 inches long; diameter of center of shaft, 38 inches; weight of fly wheel, 130,000 pounds; total weight of engine, fly wheel, and generator, 1,200,000 pounds. In general design and detail the gas engines resemble modern high-grade, massive steam engines. They are horizontal, twin-tandem, double-acting, 4-stroke cycle, giving two impulses to each crank per revolution. Each of the electric generating units can deliver 4,000 kilowatts at 13,000 volts, 25 cycles.

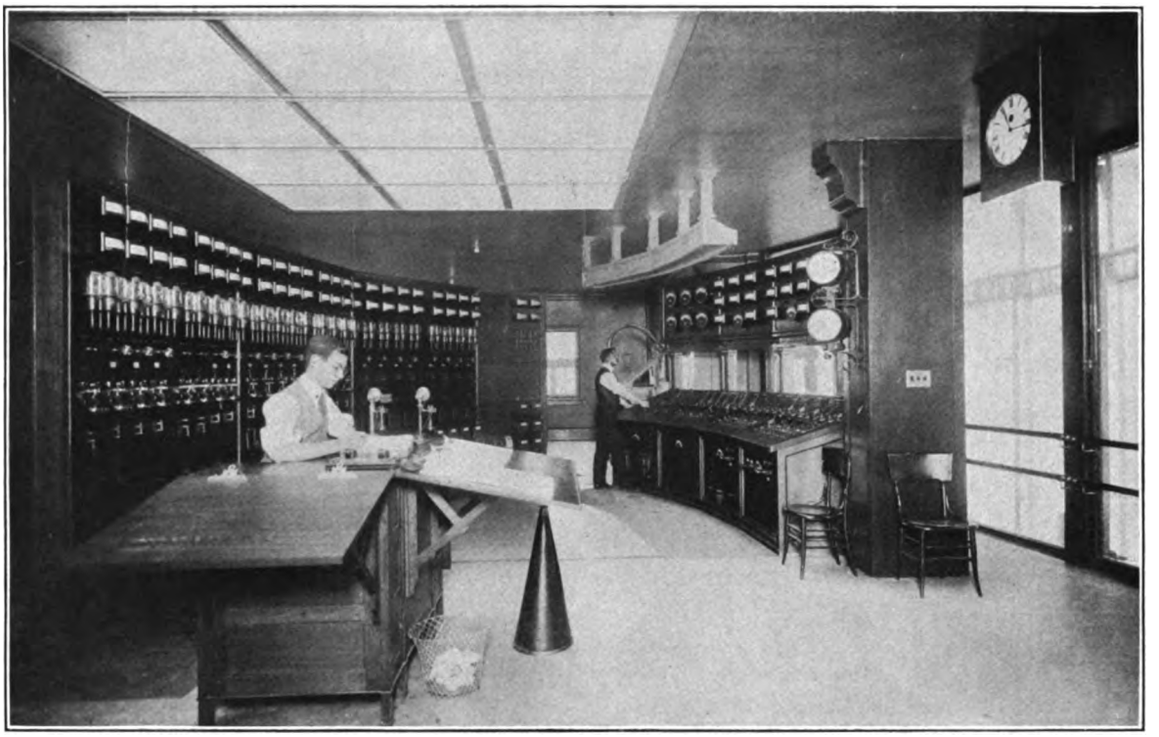
It is recognized that the gas engine itself is successful in large sizes for generating plants, but that the intrinsic efficiency of such plants depends on the gas producer, and upon the economical gasification of low grades of fuel. As has been said, the producer in its best form is the means of making available the high thermal efficiency of the gas engine to many central stations, and is the chief factor that warrants the installation of this type of prime mover at a greater installation cost than that of a steam plant. There are now producers on the market that can be relied upon to produce a satisfactory gas from many of the low grades of coal available in different sections of the country; and the result is shown, in part, in the increase in the number of gas engines from 165 in 1902 to 463 in 1907, and in their capacity from 12,181 horsepower to 55,828 horsepower.

As an illustration of complex conditions, the Keene Gas and Electric Company, of Keene, N. H., may be cited, which uses gas, steam, and water power in three separate plants. The company's gas plant, distant only 1¼ miles from the business center, contains two 250-horsepower anthracite gas producers and three gas engines of the vertical three-cylinder type, the two smaller engines being each connected to an 80-kilowatt alternator, and the largest unit to a 110-kilowatt alternator. The fuel requirements are less than in a steam plant of equal capacity, and the fuel feeding and ash discharging for the producer are accomplished by the action of gravity alone.

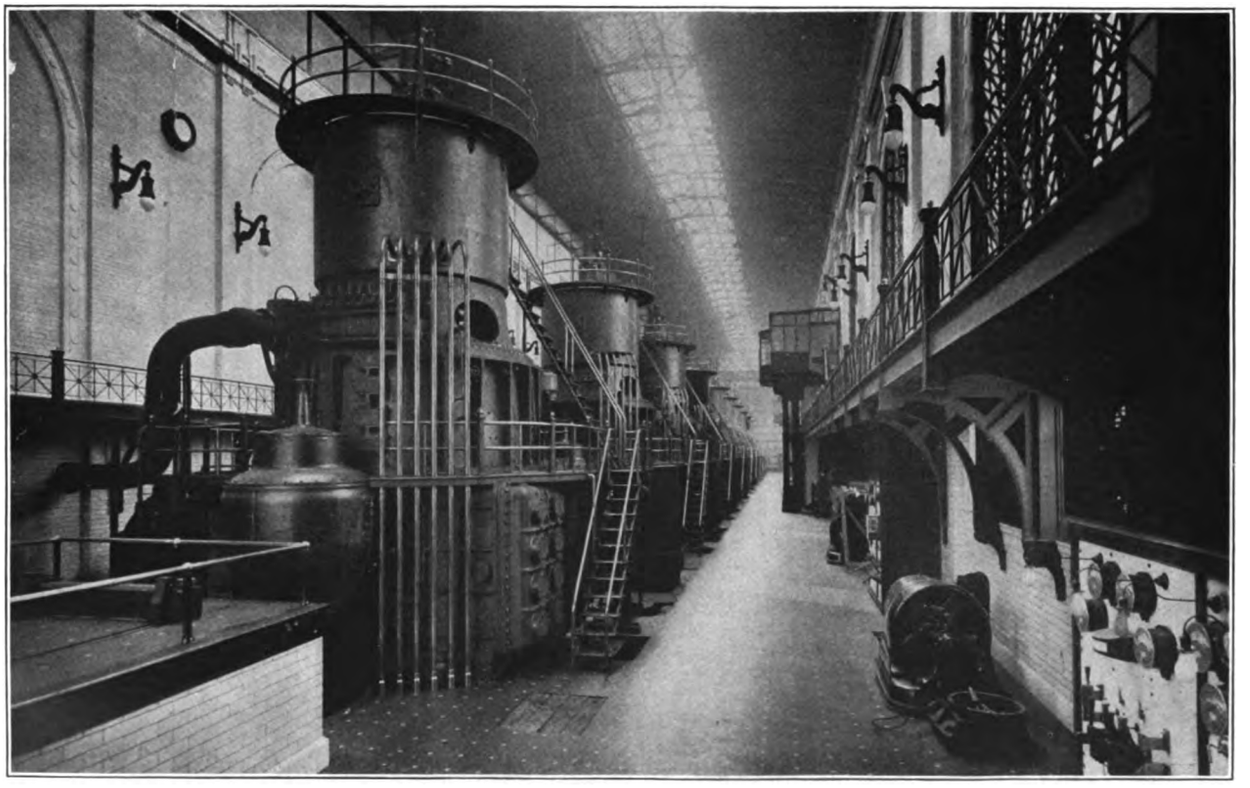
Water power.—The statistics in Chapter III as to water power are clearly indicative of the general trend of practice. An immense increase is shown both in the number and size of water wheels. In 1902 there were 1,390 water wheels, having a capacity of 438,472

[1] Proceedings, National Electric Light Association, 1909, Vol. II, p. 232.

Digitized by Google



SWITCHBOARD ROOM, QUARRY STREET STATION, COMMONWEALTH EDISON COMPANY, CHICAGO.



STEAM TURBINE GENERATING PLANT, FISK STREET STATION, COMMONWEALTH EDISON COMPANY, CHICAGO

Digitized by Google

Digitized by Google

horsepower, while in 1907 there were 2,481, having 1,349,087 horsepower. Thus the size per unit rose from an average of about 315 horsepower to 544 horsepower. The units are classified as "water wheels," but in practically every instance a more correct designation would be "turbine." In compiling the statistics, no attempt was made to differentiate between impulse and reaction types, or between installations as having horizontal or vertical shafts; although all these features have necessarily an intimate relationship to the character of the electrical generator associated with the driving wheel.

The most notable developments of the period 1902 to 1907 have been those at Niagara Falls and those in the Sierras of California; but in every part of the country where water powers lay undeveloped, enterprises on a large scale have been set on foot for the purpose of hydro-electric generation and power transmission. In fact, the period named may be regarded as one of great speculative activity in this respect, with the result that many plants have come into existence that remain unprofitable, either because the work has been too costly, because there is little market for the energy when developed, or because the problems of economical and uninterrupted transmission have not been mastered.

A water-power plant of somewhat unusual character is that of the Indiana and Michigan Electric Company, on the St. Joseph River at Berrien Springs, Mich., serving northwestern Indiana and southwestern Michigan. It was built during the intercensal period and placed in service during 1908, and is of the low-head system, capable of producing 7,200 kilowatts. The company has a total of 25,000 horsepower in its steam and water power plants, the four of the latter all being on the St. Joseph River. This river has a maximum flow of only about twenty-five times the minimum, and the actual head at Berrien is only 21 feet, gained by backing up the flow for more than 10 miles by a dam nearly one-third of a mile long, the back flow extending to the next plant above. The power house stands lengthwise to the dam. The low head made necessary considerable complication in the water-wheel plan. Each of the four generators installed is driven by a group of four pairs of wheels working under a normal head of 20 feet. The generators, rated at 1,800 kilowatts each, 60 cycles, are driven at 150 revolutions per minute. The river runs over and through a mass of glacial drift, with a hardpan bottom, and to prevent loss of water by flow under the apparent bottom of the river, a continuous line of sheet-steel piling was driven in clear across the river down to hardpan, under the upstream side of the dam; while a similar defense of mail was put across the downstream side to prevent any backwash. These elaborate precautions were taken primarily to prevent the passage of water under the dam or the scouring of the river bed below the latter, and thus preclude any possibility of undermining the structure.

Another plant of somewhat unusual character is that put in operation in 1907 by the Patapsco Electric and Manufacturing Company, of Ellicott City, Md., whose power house on the Patapsco River about 10 miles west of Baltimore is built entirely within the dam and is thus completely under water. The same structure thus serves both as dam and as power house; the available fall is utilized, and with slight modifications the suction force of the spillway water as it rushes over the mouth of the tailrace may be employed to increase the effective head by lowering the water level in the race well. With power houses as ordinarily constructed below the dam, the contrary effect obtains. Abundant natural light is had through windows located on the downstream side of the dam, beneath the falls, and natural ventilation is also provided. The generating alternators when under load furnish sufficient heat to dispel any dampness that may manifest itself; and, although somewhat restricted as to space, the power house is as comfortable as any other station building of like capabilities. The plant has a capacity of 600 kilowatts, with provision for another 300-kilowatt unit, and the electrical energy is employed for lamps and motors.

The structure represents the latest development in dam design. Heretofore, solid masonry has been considered the only safe and permanent device to impound water, reliance being placed on the enormous weight of the dam to resist the water pressure. At Ellicott City the water pressure is utilized to maintain the position of the dam, the upstream side being so proportioned and shaped that the weight of the water upon it equals the horizontal-pressure component. The dam is merely a shell in which the necessary rigidity and strength are secured by a very small fraction of the material needed in the old-style construction. The deck and apron are supported on buttresses and have a section just sufficient to resist bending under water pressure, a large factor of safety, of course, being allowed. The structure may be built in considerably less time than a solid dam, and the interior may be utilized, as in this instance, for housing the electrical equipment. In 1907 two plants of the same character as that at Ellicott City were begun, one at Delta, Pa., and the other on the Big Horn in Wyoming—each having a head of water of about 60 feet and developing about 1,500 kilowatts.

No inconsiderable amount of modern hydro-electric development in the West is associated with irrigation work. One of the most noteworthy and recent examples is connected with the Custer reservoir in San Miguel and Dolores counties, Colo., where a dam 110 feet high impounds 756,800 acre-feet of water, to be employed in power development and irrigation. Another work of this character, which has been under construction for some time and will be completed before April, 1910, is the Orchard Mesa irrigation project, extending from Grand Junction to Palisade, in the richest fruit district of Colorado.

Digitized by Google

During 1906–7 the municipality of Lynchburg, Va., installed a plant which is somewhat typical of the older methods, in that the current is not transmitted a long distance, and that the energy is employed for ordinary arc-lighting purposes. This plant utilizes the flow of the James River, and occupies an old pumping station that was part of the municipal waterworks before the new gravity system was introduced. An operating head of only 12 feet has been skillfully employed. The plant is laid out for the use of series alternating current, to avoid the use of transformers between the generators and the series circuits. The generating dynamos are 2-phase alternators designed to supply 15 amperes per phase at 4,200 volts. The arc lamps are supplied with 7.5 amperes at 80 volts. This gives two circuits per phase, with 50 lamps on each circuit, or 200 lamps per generator. An inductive regulator is placed in each circuit which will automatically maintain a constant current of 7.5 amperes through the lamps.

Niagara remains, of course, the preeminent example of hydro-electric development in the United States. Grouped around the great falls are seven generating stations, whose supply of electrical energy is in demand over a very large area of consumption. Figures reported for 1908–9[1] show that the energy from Niagara Falls is used at the rate of 126,800 horsepower for electro-chemical processes, 56,200 horsepower for railway service, 36,400 horsepower for lighting, and 54,640 horsepower for various industrial services, or a total of 274,040 horsepower. Since the water of Niagara Falls represents probably more than 5,000,000 horsepower, it would seem that only about 5 per cent of the available power is being utilized at present. As to the proportion of energy from Niagara Falls used locally as compared with that transmitted elsewhere, figures in the article referred to above show that 12,300 horsepower is transmitted more than 100 miles; 33,500 horsepower, 75 miles and less than 100; 3,100 horsepower, 50 miles and less than 75; 79,640 horsepower, 10 miles and less than 50; while 145,400 horsepower is used locally on the Canadian and New York sides of the falls. That is to say, somewhat more than 50 per cent of the energy actually utilized is employed locally, and almost all of this is used in industries that have been attracted to Niagara Falls by reason of the generating stations located there. Electro-chemical processes take 87 per cent of the energy that is consumed locally and 46 per cent of the total amount utilized.

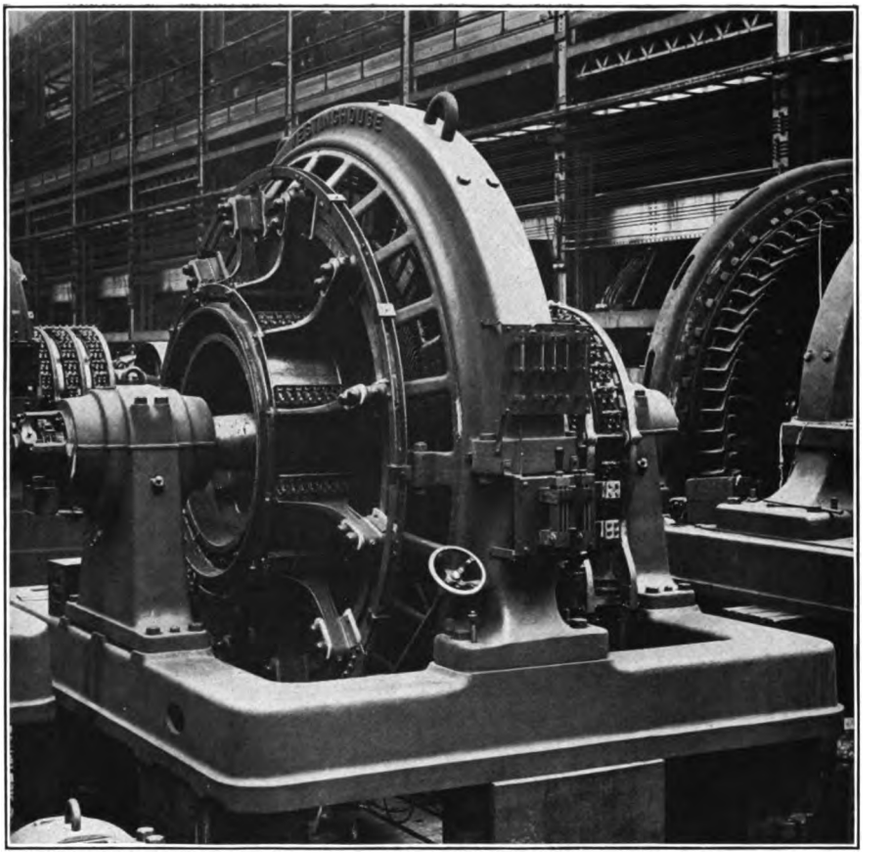
What is believed to be the largest turbine of its type ever built is that put in operation during 1905–6 by the Seattle and Tacoma Company at its Snoqualmie Falls plant, 35 miles east of Seattle, Wash., a single-wheel turbine of 10,000 horsepower capacity. The 12,500 horsepower vertical turbines of the Electrical Development Company, the 10,000 horsepower horizontal turbines of the Ontario Power Company, and the 10,000 horsepower vertical turbines of the Canadian Niagara Power Company, all of which are at Niagara Falls, Ontario, are duplex machines, as each unit has two runners on a single shaft driving a single generator. The Snoqualmie Falls turbine, with but one wheel, therefore, represents by far the largest concentration of power yet accomplished in turbine water wheels. The turbine in question is employed in an enlargement of the Snoqualmie Falls plant to double its original capacity.

Generators.—The statistics of Chapter III are very complete as to the generator, or dynamo, equipment of American central stations in 1907, and reveal clearly the changes that have taken place and are still in progress in the manner of generating electric current. At one time the central stations of the country were wholly on the basis of direct current for incandescent lighting, arc lighting, and motor supply, and direct-current generators predominated to the exclusion of any other type. Now the vast majority of stations are on the basis of alternating current, even if they deliver direct current to the consumption devices. As shown by Table 34, there were in use in 1907 for generating direct current, either of constant voltage or of constant amperage, 5,365 dynamos of a total capacity of 487,452 kilowatts, as compared with 6,808 machines of 2,221,773 kilowatts capacity employed to generate alternating current. In 1902 the alternating-current dynamo was already in the lead as to capacity, though somewhat inferior as to number; but the five years witnessed a remarkable diminution in the number and capacity of dynamos of constant amperage designed strictly for the old arc-lighting service, and in reality capable of nothing else. The number fell off from 3,539 to 1,685, and the capacity from 145,866 kilowatts to 80,992 kilowatts; and it is probable that during the period in question few, if any, new machines of the old type were built. If there were any new machines intended specifically for arc-lighting purposes, they will be found in the alternating-current group, where their presence tended to keep down the average capacity per unit to 326 kilowatts, although this is far above the average per alternating unit shown for 1902, which was below 144 kilowatts.

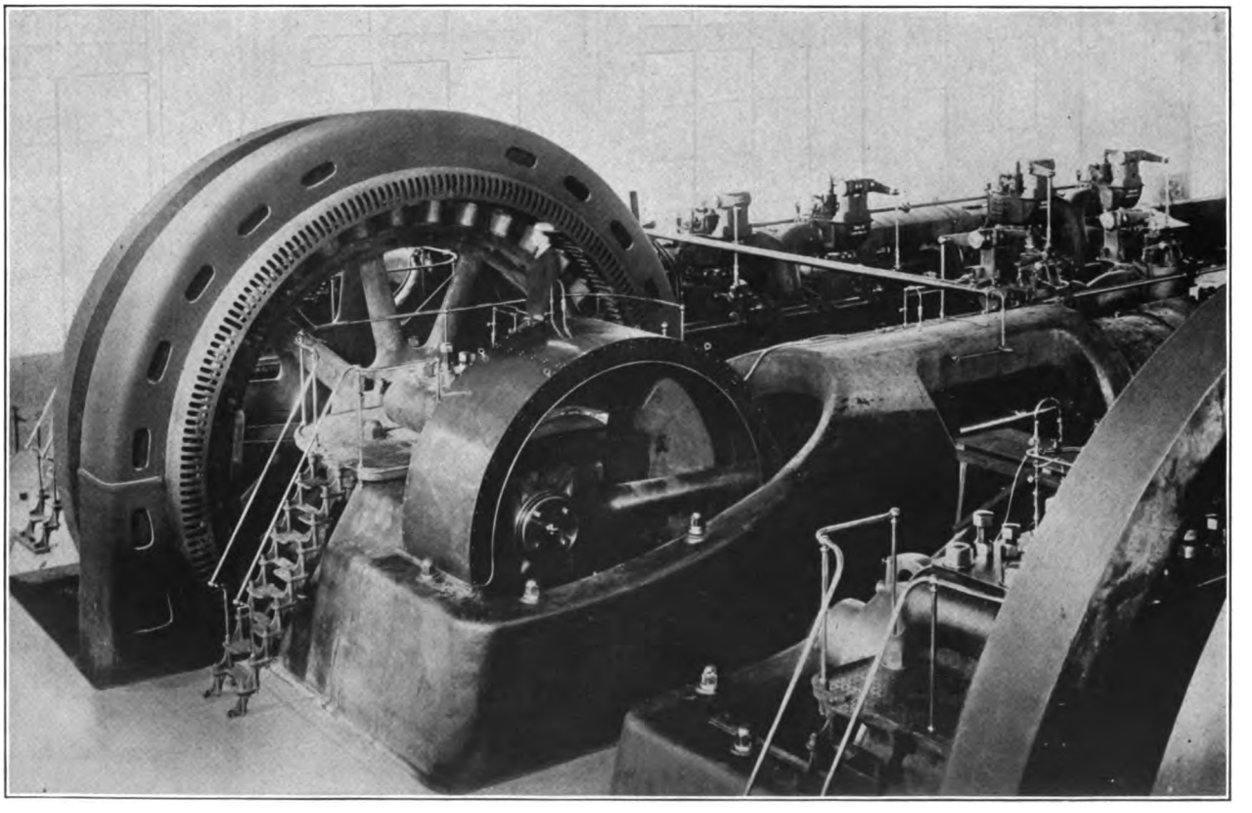
Thus the interesting and significant fact emerges that although the generator capacity in the five years more than doubled, rising from 1,212,235 kilowatts to 2,709,225, the number of dynamos actually declined from 12,484 to 12,173. How far this concentration will go it is hard to say, but the tendency is plainly visible. At the beginning of 1908, for example, there were 345 central stations in New York state. It has been conservatively estimated that with the methods and apparatus now in use for generating, transmitting, and distributing current, the whole state could be much more economically and efficiently supplied from 10 stations each with a radius of about 50 miles. This being true, it is obvious that hundreds of the smaller dynamos would disappear and their work be

[1] Electrical World, October 21, 1909, p. 978 et seq.

Digitized by Google



1,500-KILOWATT ROTARY CONVERTER.



GENERATOR CONNECTED TO LARGE GAS ENGINE, SAN FRANCISCO.

Digitized by Google

Digitized by Google

done by relatively few machines of greatly increased capacity. The radical modifications of all kinds that would follow such a change in generating methods, which is entirely feasible, lie beyond the scope of this report.

Of late years there has been little development in the design of such direct-current machinery as is included in this report, and what has been done aims rather at refinement and perfection than the adoption of new ideas. All the real work of development is concentrated on the alternating-current types, especially those driven at high speed by steam turbines. The size of 3-phase alternating-current dynamos has been carried as high as 14,000 kilowatts, with an overload capacity 50 per cent above normal rating. These generators have a frequency of 25 cycles per second and produce current at 11,000 volts pressure, usually for delivery to rotary converters which so manipulate it as to make it possible for lamps and motors on the circuit to use direct current at a low safe pressure. Such a machine is capable of energizing to full brilliancy 560,000 tungsten incandescent lamps of 25 watts and 20 candlepower, giving a total light equal to 11,200,000 candles.

Where such a machine is to furnish current for lighting rather than for motors, it is usual to employ a frequency of 60 cycles, as with a lower frequency there is an appreciable flicker in the lights. Dynamos of such design are operated either horizontally or vertically, and either the armature or the field magnets may be revolved. A revolving-field generator of 14,000-kilowatt capacity is among more recent developments, operating at 6,600 volts, 60 cycles, 3-phase, direct-connected to the vertical shaft of a steam turbine running at a speed of 720 revolutions per minute. This huge machine has a peripheral speed of 18,300 feet per minute and an output per pole of 1,400 kilowatts, as compared with a peripheral speed of 8,000 feet per minute and an output per pole of 150 kilowatts in a reciprocating engine-driven alternator of the same capacity and frequency, operating at 75 revolutions per minute. The electrical and magnetic losses in the field and armature of such a machine of 14,000-kilowatt capacity amount to about 350 kilowatts, and to conduct this heat away from it in order to prevent local high temperature requires about 140,000 cubic feet of air per minute at usual dynamo-room temperatures. In order to regulate the movement of the ventilating air, the generator is entirely closed, with the exception of the intake and discharge openings at the top and bottom of the armature. Thus when the machine is running, its revolving field operates as a powerful fan. Air received through the openings in the ventilating hood is forced through passages provided in the field and the armature, and discharged at the openings in the base of the generator.

Now that so much of the current is generated by alternators, a large quantity of auxiliary apparatus is required of various forms. In the smaller plants the transformer capacity for lowering the potential is usually from 50 to 75 per cent greater than that of the generating apparatus, while in many of the larger systems, it is stated, the combined capacity of the converting and transforming apparatus is approximately three times as great as that of the generators. Transformers will be dealt with later; but reference may be made here to the apparatus which is of a generating character in design although it adds nothing to the capacity of the plant, simply rendering the energy produced more available for miscellaneous use. Thus current is often changed in voltage or phase and frequency changers have been widely adopted. These may be either synchronous or nonsynchronous, depending upon the degree to which exactitude in the change of frequency is carried. One part of the machine is motor, receiving the current to be changed, the other generating and delivering to the line the current produced or "manipulated." In recent work the vertical shaft type has been largely introduced in capacities of from 2,000 kilowatts upward. One machine designed for the Commonwealth Edison Company of Chicago, built while this report was in preparation, which changes from 25 to 60 cycles, is of not less than 6,666 kilovolt-ampere capacity, with 75 per cent load factor, and is probably the largest of its kind in existence.

While in a few cities the alternating current produced locally or received from a distance is used without any change to direct current, it would appear that in the consumption circuits and apparatus direct current is still preferred, in the standard voltages, from 110 up to 440. Because of this, the demand for "rotary converters," as they are called, is very large. These machines, of the synchronous type, have become the standard form of converting apparatus for low-frequency substations delivering low-pressure direct current to line. They receive the alternating current on one side and send out the direct on the other. Occasionally their place is taken by motor-generator sets in which there are two machines driving on the one horizontal shaft, the motor part of the device receiving the alternating current. This apparatus is, however, more in favor in Europe than in America. Probably the great majority of rotary converters enumerated in the present report are of the horizontal-shaft type, with collector rings at one side and the commutator on the other, but to meet the exigencies of limited floor space vertical shaft units have been manufactured, such as those of the 6-phase, 25-cycle, 250-volt, 2,500-kilowatt capacity designed for the New York Edison Company.

The extent to which apparatus of the auxiliary character described above may be needed, even for systems within city limits operating at pressures not to exceed 9,000 volts, can be inferred from the fact that at the end of 1907 the Commonwealth Edison Company of Chicago had a "peak-load" generating

Digitized by Google

output of 119,250 kilowatts in three stations. It sent its electrical energy to no fewer than 33 substations of the system within the corporate limits and to 11 substations belonging to various railway companies taking current for the operation of their cars. The rotary-converter rating connected to the 115-volt and 250-volt direct-current network in the central part of the city aggregated 50,700 kilowatts. The alternating-current motor-generator frequency-changer sets, through which 60-cycle energy was supplied to outlying districts, aggregated 21,340 kilowatts. To this must be added the similar auxiliary equipment of the railways, making the formidable total of 122,940 kilowatts. It might be added incidentally that the system also included, for discharging into its direct-current network in the heart of the city, storage-battery plants fed through the rotaries, etc., aggregating over 18,000 kilowatts in output at a one-hour rate of discharge.

Transmission.—It has already been intimated in the preceding discussion that the development of the central-station industry has depended materially upon advances in transmission methods and apparatus. While this is true, little that is revolutionary has been developed during the period. In fact, one of the leading authorities, Dr. Louis Bell, discussing the subject early in 1908, said: "Much of the power-transmission work of the last five years has been of an unobtrusive character, mere extension, without material change of what had gone before." [1] Nevertheless, a survey of the progress made discloses conditions that were a few years ago hardly deemed to be within the range of possibility, and such widespread extension of transmission systems as to constitute a new industry and a new well-defined branch of engineering to which experts give their whole attention.

While the voltage of generators furnishing current for either long or short distance transmission has remained around 2,000 to 2,500 volts, the pressure on lines has been boldly carried from 10,000 volts up to 100,000, and the latter figure seems to be by no means the limit, since far higher potentials are being discussed or are under experiment, with serious thought of their ultimate adoption. The raising and lowering transformers appear to be equal to all the strains thus far put upon them. It has been a common practice to equip such high-voltage transformers with taps on the high-voltage side, so that they may be worked at 5 or 10 per cent below their full voltage. In the earlier stages of the industry separate transformers were used for each phase of a 2 or 3 phase system, but now composite 3-phase transformers are a common type, and no difficulty has been experienced in providing them for pressures of 100,000 volts and upward.

The circuits are usually of bare copper, and possibly the high price to which copper was carried in the "boom" period lasting up to 1907, about 25 cents per pound, may have had something to do with the effort to reduce the amount of copper in a line by raising the voltage. Aluminum has also been tried with success. The "pole lines" were originally of wood, as in the case of the first Niagara transmission to Buffalo, but steel poles and steel towers are now very general. The method of holding up the wires has varied. In California, with its dry climate, large pin-type porcelain insulators have been used with flaring "hoods" or "petticoats" to shed moisture, while another type is that of the suspension insulator. In the latter case several porcelain bells or drums, either plain or with concentric "petticoats," are strung together like reels on a thread, the uppermost insulator being carried by the cross-arm, and the lowest in the series supporting the transmission wire. The bells, of uniform size, ranging usually from 10 to 15 inches in diameter, are tied together by metallic links; and four or five of these bells in a bunch have a remarkable ability for standing up with very high voltage under all manner of adverse conditions of weather. The circuits are now more widely spaced, the separation averaging a foot per 10,000 volts; so that there is little risk of disturbance from anything except lightning. Many of the systems depend for lightning arresters upon "horn" or curved projecting ground wires of large dimensions; but others use multiple gap arresters, shunted to the ground from several points. A recent widely used type is an electrolytic lightning arrester which consists of aluminum cells, or jars, of large surface, stacked up in series.

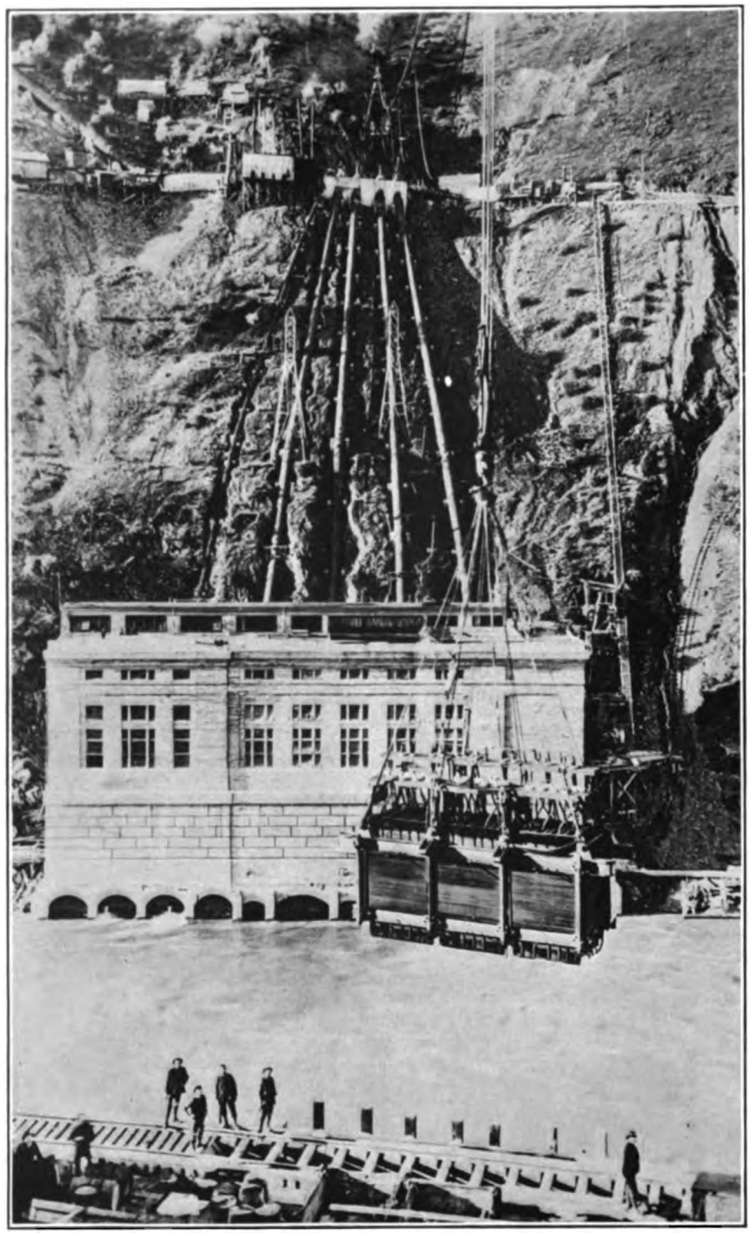
It has already been noted that the standard frequency of transmission of alternating current is 60 cycles. At Niagara Falls this frequency of transmission began with 25 cycles, and is still maintained. The vast heterogeneous network of the Los Angeles (Cal.) Edison Company operates at 50 cycles. In an address [1] before the National Electric Light Association in 1906, Mr. R. H. Ballard stated that the Los Angeles system then included 110 miles of transmission line with 33,000 volts pressure; 300 miles of double-circuit transmission with 10,000 and 15,000 volts pressure; and 750 miles of transmission line with 2,200 volts pressure in the various cities and towns served by the system; and that there were no fewer than 22 communities to which the company gave electric service with energy from all manner of sources, including a plant on the Kern River transmitting energy at 75,000 volts to Los Angeles, 120 miles away. The longest American transmission system, however, is that in northern California, where the circuits reach 232 miles, from De Sabla, in the Sierras, to San Saulito.

Another extremely long circuit is that from Niagara Falls to Syracuse, N. Y., a distance of 165 miles. The

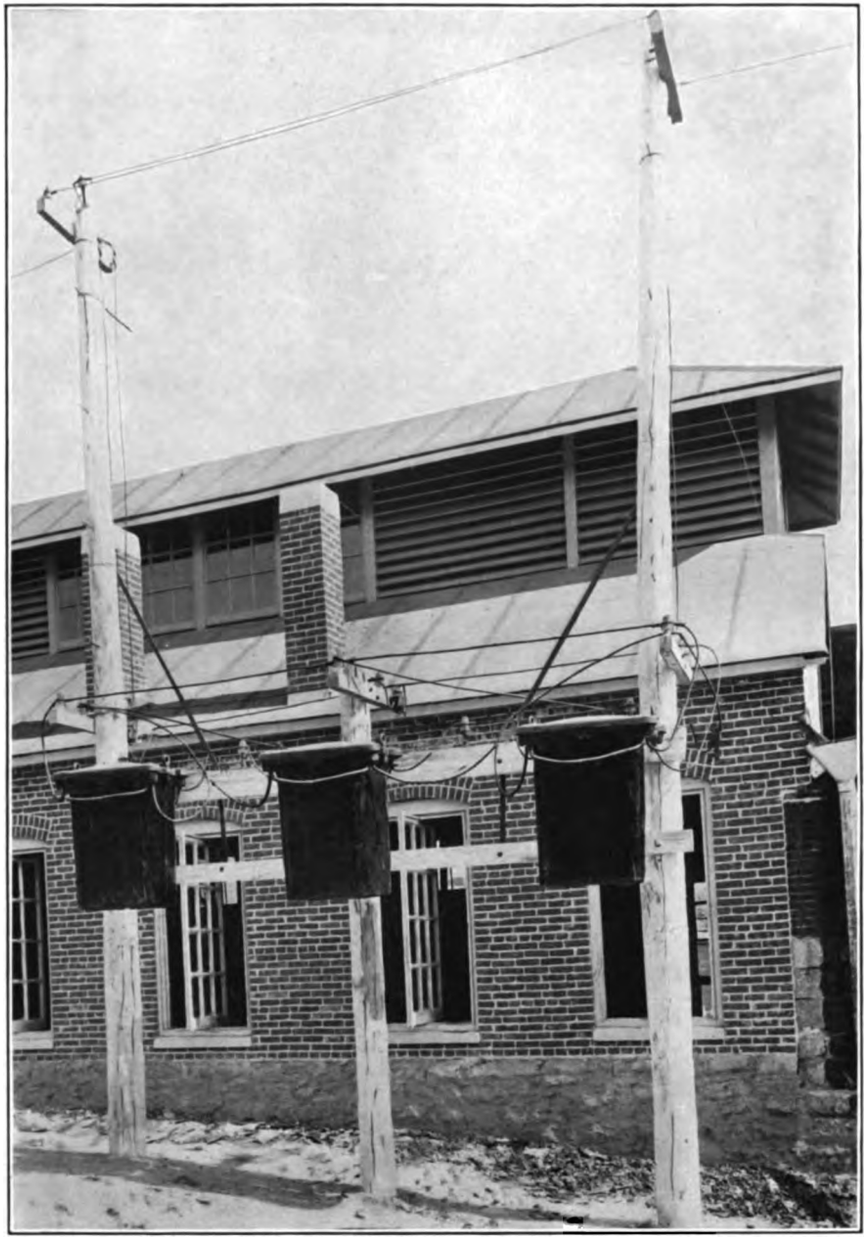
[1] London Times, June 3, 1908.

[1] Proceedings, National Electric Light Association, 1906, Vol. I, p. 636 et seq.

Digitized by Google



CONVEYING A 10,000-KILOWATT, 100,000-VOLT TRANSFORMER WITHOUT CASE ACROSS THE FEATHER RIVER, CALIFORNIA.



METHOD OF MOUNTING DISTRIBUTION TRANSFORMERS ON POLES.

Digitized by Google

Digitized by Google

following description of this circuit is based on a paper[1] read by Mr. Ralph D. Mershon before the American Institute of Electrical Engineers in 1907. The system described is that of the Niagara, Lockport and Ontario Power Company, a purely transmission enterprise, buying its energy in bulk from the Ontario Power Company, which has a plant at the base of the Horseshoe Falls on the Canadian side, where the dynamos generate 3-phase, 25-cycle current at 12,000 volts, which is transmitted to the transforming station, the circuits crossing the river in the gorge below the whirlpool. The potential is stepped up from 12,000 to 62,500 volts for the transmission lines which run on a private right of way from Lockport to Mortimer, a distance of 57 miles, and have a capacity of 20,000 horsepower. From Mortimer to Syracuse, a distance of 81 miles, the line on the company's private right of way has a capacity of 10,000 horsepower. From Lockport to a point 11 miles east and thence south on private right of way to the West Shore Railroad, and thence on the West Shore right of way to Pittsford, is another line with a capacity of 20,000 horsepower. From Pittsford to Syracuse on the West Shore right of way is a 10,000-horsepower line. From Lockport south to Buffalo are two transmission lines on private way, each with a capacity of 30,000 horsepower. Emphasis is laid on the provision made for isolating the circuits like railroad rights of way, and thus insuring safer and surer work.

Steel towers are used almost entirely, generally what is known as the "windmill type," "tripod" or "quadruped," and constructed of either lap-welded pipe, or structural steel, galvanized. The standard length of span between towers is 220 feet in some parts, 550 feet in others; while an extreme length of 1,253 feet is reached and an extreme height of towers of 75 feet. Each line of towers or wooden structures carries only one 3-phase system. The main line conductors are of aluminum, except on a portion of the line between Mortimer and Syracuse, where copper was preferred because of the long spans. Crossing the Montezuma marsh, the big steel towers have their feet deeply embedded in concrete foundations.

Three sizes of cable of "line wire" are used for the main transmitting line. The largest cable of aluminum consists of 19 strands, having a total of 642,800 circular mils, equivalent to 400,000 circular mils copper. The areas of cross section of the other cables are respectively two-thirds and one-third that of the large one. The insulator used on all main-line construction, designed by Mr. Mershon, has unusual factors of safety as regards flashing, etc., and consists of three shells of porcelain nesting into each other and cemented together with neat Portland cement, the whole insulator being cemented in a similar manner to a steel pin before attachment to the tower. The insulator is 19 inches in total height and the upper "petticoat" has a diameter of 14.5 inches. The lines are most liberally provided with fuses to cut out the circuits in case of trouble, and with disconnecting switches and lightning arresters. Speaking of the elaborate arrangements for protection against lightning, Mr. Mershon says:

> Another feature out of the ordinary in connection with this station is the lightning-arrester equipment. This equipment is also out of doors and consists of a number of horn-type arresters mounted on wooden poles, in much the same manner as such arresters are ordinarily mounted. The installation differs, however, * * * in that, instead of there being only one pair of horns for each conductor, there are three such pairs. One pair is set for a comparatively low-striking electro-motive force and has in series with it a high resistance; the next pair is set for a higher-striking electro-motive force and has in series with it a lower resistance. A third pair is set for very high-striking electro-motive force and has in series with it a fuse. The theory on which these arresters are installed is that for ordinary slight static disturbances in the line, the arrester having the lower-striking electro-motive force will discharge, and since it has in series with it a comparatively high resistance, the resultant disturbance to the system due to the generated current which follows the discharge will be comparatively slight.

The Grand Rapids-Muskegon plant and system may also be cited. They were installed in 1906–7, with 66,000 volt transmission in circuits totaling about 75 miles, supplying the Grand Rapids Edison system, various interurban and local trolley railways, and several large industrial plants. In the following year 35 miles of steel-tower line were added, and the potential has since been raised to 80,000 and 100,000 volts with success. These later circuits use the suspension type of porcelain insulator. Five of these insulators are hung, horizontally, one above the other, like beads. Each is 10 inches across, and the rated voltage it will withstand is 23,000 volts per "link."

Distribution.—The standard methods of distribution have remained the same throughout the country, with occasional interesting variations for some particular purpose. It may be noted that the new metallic filament lamps favor the 110-115-volt circuits to which Americans have steadily adhered through many years. In the United States the 220-volt, 3-wire system is the rule, but in Europe, and especially in Great Britain, the 450-volt, 3-wire system is equally the rule. One system employs 110-volt lamps on each side of the neutral, and the other requires 225-volt lamps. It is obvious that copper economics are with the 450-volt system, but on the other hand, the lamp efficiencies are with the 220-volt system. In Europe, moreover, the standard lamp is 8-candlepower instead of 16-candlepower, and it is the fact that here again the lamp efficiencies are with the 110-volt lamp of the higher candlepower. It would seem, therefore, that there is no immediate prospect of a change of American distributing circuits from 220 to 450 volts on the 3-wire distributing networks, but that, on the contrary, the new lamps will find a wider market than heretofore while confirming the practice at 110 volts.

[1] Transactions of the American Institute of Electrical Engineers, vol. 26, Part II, p. 1273 et seq.

Digitized by Google

An interesting innovation is that made by the Toledo (Ohio) Gas, Electric and Heating Company, in the adoption of a 4,600-volt system of alternating-current distribution. The transformers on the system are wound for 4,600 primary and 110–220-volt, 3-wire, secondary distribution. Current is generated 3-phase, but the distribution is single-phase. The generators are star-connected with the neutral grounded. The transformers are delta-connected. In the construction unusual care has been taken to avoid trees by running the lines high. Insulators and fuses are, of course, more expensive than for the usual standard of 2,300 volts.

Another interesting change was that made during the intercensal period by the Denver Gas and Electric Company from direct to alternating current in territory just outside the business district of Denver, Colo. The company had for motor service a 220 and 440 volt, 3-wire, direct-current power distribution, most of the energy being used in and near the down-town district. The lighting distribution of the whole city is by single-phase feeder lines supplied from 3-phase bus bars at the power station. The direct-current motor feeders were becoming so long and the number of distant customers so large that an excessive amount of copper was called for. The decision was made to change the motor service outside of the down-town district to 3-phase, and to give customers new 3-phase induction motors in place of their direct-current motors. Most of the direct-current motors were sold at good prices. The direct-current copper taken down was worth enough to reduce materially the cost of the change. A puzzling question was to decide whether to use 220 or 440 volt motors. With 220-volt motors but one customer could usually be supplied from a bank of transformers, whereas with 440-volt motors and secondaries several in one locality could be supplied. The latter advantage was considered to be more than counterbalanced by the fact that with 220-volt motors standard lighting transformers could be used. The change was made without interrupting any customer's service.

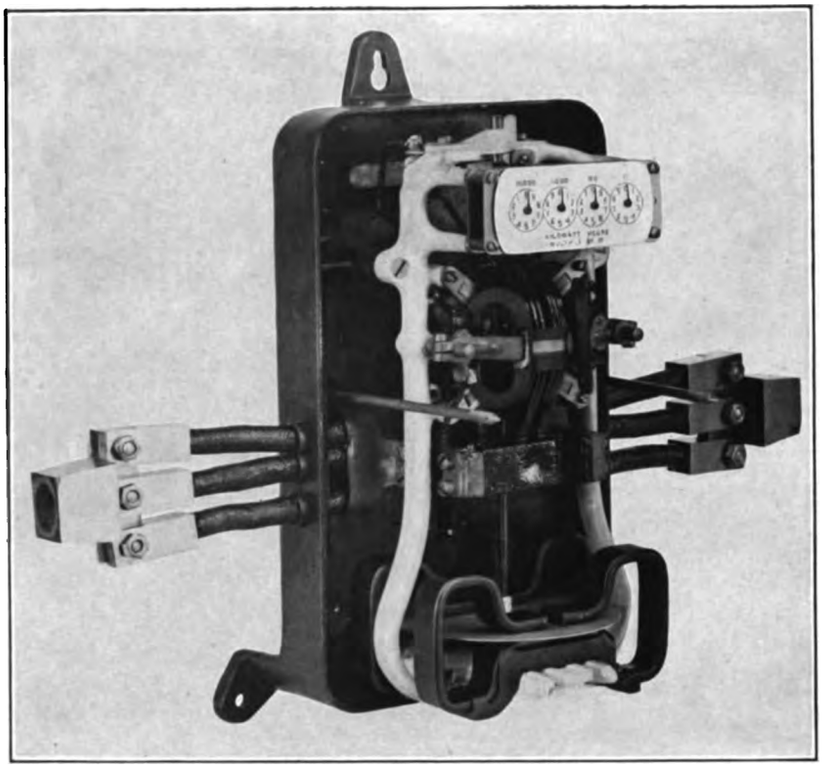
The central station company in Detroit, Mich., on establishing its new plant at Delray, 4 miles from the business center, installed machinery for the generation and transmission of electrical energy at 4,600 volts, 3-phase, 60 cycles, and developed an extensive power service to factories direct by means of such current. Incidentally it may be mentioned that one of the reasons for placing this plant at Delray on the salt beds was that by using the exhaust steam of the power plant to evaporate the brine from the wells a very economical and profitable day load was secured.

Transformers.—This class of apparatus, so necessary to power transmission by electricity, is also used largely in distribution circuits, and may therefore be properly considered at this point before taking up the "consumption devices," by which the electrical energy is used up in doing its work. Transformers were fully described in the previous report and in the reports on the manufacture of electrical apparatus,[1] and therefore need not be considered here in great detail. The most important features in the recent development of transmission methods have been the introduction of a large number of the modern transformers employed to "raise" and "lower" the voltage, and the adoption of composite 3-phasers instead of a separate transformer for each phase. The size is determined, of course, by the general capacity of the plant and the amount of energy passing out or in over the respective circuits. The Ontario Power Company, on the Canadian side of Niagara Falls, which delivers current for use over a large part of New York state south of Lake Ontario, employs transformers each of which has a capacity of 3,000 kilovolt amperes, and weighs, when filled with its insulating oil, approximately 50 tons. The current is received from the generators at 12,000 volts, and after being raised to 36,000 volts in the secondary winding, a line voltage of approximately 62,000 volts is secured by connecting the transformers two in series. At the Great Falls (South Carolina) power plant of the Southern Power Company the transformers are rated as of 2,000-kilowatt capacity. They are oil-insulated and water-cooled, and take 2,300-volt current from the generators, raising it to 44,000 volts for the line. By means of multiple connections inside or outside the transformer tank, 1,900, 2,000, 2,100, 10,000, and 22,000 volts can also be obtained. Oil for the transformers is furnished either by gravity or under pressure. Circulating water, for transformer-cooling purposes, is obtained by gravity. With a rise in temperature not exceeding 60° C., a circulation of 4 gallons of water per minute at full load is required; while with 5 gallons per minute and 1.25 load, the temperature will not exceed, by 55° C., that of the intake water during continuous operation. All the transformers are connected to a piping system by which carbonic acid gas can be admitted in case of fire.

As shown in Table 40 of Chapter III, main-station transformers were not enumerated in 1902, but in 1907 their number was reported as 1,577, with 592,708-kilowatt capacity, which is in itself a fair indication of the amount of "transmission" work done in the country. As was remarked in that chapter, there was little uniformity among the companies in the manner of reporting their miscellaneous equipment of this character. While the main-station transformers, therefore, are probably reported with fair accuracy, considerable doubt attaches to the statistics for what may be called the substation equipment, because here the border line to distributing apparatus in some instances is crossed. In Table 41 substation transformers to the number of 4,211 were reported for 1907, with 1,100,824-kilowatt capacity, while in

[1] Census Bulletin 245, Electrical Apparatus and Supplies, 1902, p. 10: Bulletin 73, 1905, p. 25.

Digitized by Google



400-AMPERE, 116 TO 120 VOLT METER UNCASED TO SHOW MECHANISM.

HIGH-VOLTAGE TRANSFORMER SOUTHERN POWER COMPANY.

MODERN TYPE OF DISTRIBUTION TRANSFORMER.

Digitized by Google

Digitized by Google

1902 only 1,800, of 312,848-kilowatt capacity, were reported. It will be observed that the substation or receiving transformers are just about double the total capacity of the main-station transformers.

Three of the largest transformers in existence were manufactured during the year 1908–9 for the Great Western Power Company of California. The main power house of this company is located on the Feather River, near Oroville, in the county of Butte. The ultimate head of water developed is 525 feet, and 40,000 horsepower is transmitted at 100,000 volts to points along the coast 165 miles distant. The total weight of each of these monster transformers is 128,000 pounds, of which 40,000 pounds is due to the 5,000 gallons of oil used in each machine for cooling and insulating purposes. Each transformer is shaped like a giant wash boiler, stands 20 feet above the floor, and measures 9 by 18 feet. When these machines are working they each transform 10,444 kilowatts of electrical energy from a low voltage to a high voltage at the remarkably high efficiency of 98.6 per cent. The transformers for the Great Western Power Company are slightly larger than the six recently installed for the Great Northern Company of Duluth, Minn., which are in successful operation.

In Table 53 of Chapter IV the number of "distributing" transformers, or those on customers' circuits in 1907, is given as 299,489, with a total of 2,058,567-kilowatt capacity. There was a marked tendency toward an increase in size. The average capacity of these transformers more than doubled during the five years ending 1907, namely, from a little over 3 kilowatts to nearly 7. There has also been a great improvement in the construction of such transformers during the past five years. On this subject Mr. W. K. Layman[1] says:

> Much of this improvement has been the result of a continuous and, recently, quite sharp improvement in the magnetic quality of sheet steel. The latest quality of transformer steel has been exploited under the various names of silicon steel, alloy steel, silico vanadium, and the like, with claims of individuality for each. The substantial fact is that these names are synonymous. They all refer to a quality of material in which the percentage of silicon has been greatly increased over that previously prevailing over the art. In chemical composition, the best material, as commonly employed in use to-day, shows the following analysis:

	New steel.	Old steel.
Combined carbon	0.070	0.080
Manganese	0.170	0.240
Sulphur	0.023	0.050
Silicon	3.700	0.094
Aluminum	1.314	0.050

> It has been known from a very early date in the history of commercial transformers that silicon improves the quality of steel for transformer purposes, and some of the early technical writers explained the nonaging quality of impure steels, as compared with the pure, on the score of the presence of appreciable quantities of silicon. Manufacturing difficulties are said to have held back a quality of steel with as much as 3 per cent of silicon until about two years ago, when European mills began producing successfully this high silicon material, and very quickly its manufacture began here.

This change in chemical composition, together with special heat treatment by the manufacturer, has resulted in a marked improvement in the magnetic quality of the steel. The saving in internal energy losses with this material, as compared with the old, averages about 25 per cent. With this new material, if the weight is left the same, the performance will be greatly improved. If the performance remains unchanged, the weight is greatly reduced. Manufacturers have in general compromised between the two extremes and have built transformers lessened somewhat in weight but substantially improved in performance. Distributing transformers of modern type are usually for pole lines or for manholes, and differ in their adaptation to such specific use. If for pole-line service, the transformer is made as weatherproof as possible. If for manhole use, it is made water-tight or air-tight. As to the usual requirements, Mr. E. G. Reed said in a paper[1] read before the National Electric Light Association:

> Standard transformers are made for only two voltages on the primary side—and in case of particular requirements a special transformer should be secured. For this reason modern commercial transformers are made for only two voltages on the primary side—that is, nominally 1,100 and 2,200 volts—and two voltages on the secondary—that is, nominally 110 and 220 volts. Standard transformers must be designed to operate at 1,100 volts, as well as at 2,200 volts, since there are still a number of stations using this voltage, though their number is decreasing. There is a limited demand for transformers with multiple-ratio taps on the primary winding, and sometimes for units having three secondary voltages. Such transformers can be secured for prices slightly higher than for the standard line. The demand for transformers having three secondary voltages arises from the convenience which at times results from having units which are interchangeable for light and power service. Lights are operated at nominally 110–220 volts, and motors at nominally 220–440 volts. The performance of the transformers with three secondary voltages is slightly inferior to that of the standard lines, which will probably more than offset the interchangeable feature. The increased complexity of the transformer provided with the numerous voltage combinations renders more likely a wrong connection when installing and the more chance of losing transformer by burn-out.

Storage batteries.—This class of apparatus has been found a necessary adjunct in most central stations or their substations in large cities, and is also found associated with many of the power-transmission systems. Persons familiar with the operation of storage batteries will appreciate the difficulties to be encountered in securing data as to number or capacity. While some figures are given in Table 40, Chapter III, as to number, which may be accepted as reasonably accurate, indicating a considerable increase in the number of cells, no effort has been made to report the

[1] Practical Aspects of Recent Improvements in Transformers, in Proceedings, National Electric Light Association, Vol. II, p. 220 et seq., 1909.

[1] Proceedings, National Electric Light Association, 1909, Vol. I, p. 581.

Digitized by Google

capacity, owing to the different methods in vogue of rating them or of employing their capacity.

At an earlier period batteries were used to even up the load on the generators in large central stations, but they are now used principally for emergency or "stand-by" service in substations and for carrying peaks of short duration. Their plates have therefore been designed to give the maximum output of energy for short and infrequent periods with a minimum first cost, upkeep, and space requirements. As a result the plates of later type will give nearly twice the output of the old plate, for twice the time, with a higher terminal voltage. Another development in such emergency service has been in connection with the auxiliary apparatus. End-cell switches that travel at high speed over the bars and are capable of carrying current up to 20,000 amperes for short periods have been successfully introduced. These switches can cut in or cut out from one to three cells per contact point, while carrying the maximum current, involving a great reduction in the cost of the copper conductor bars, since the number of runs from the end cells is reduced.

The use of batteries has enabled central stations to secure and execute large contracts for power that might otherwise have escaped them and fallen to isolated plants. In this connection Mr. Joseph Appleton, in a paper[1] read before the National Electric Light Association, says:

> Equally important to the development of the emergency or stand-by battery comes the improved regulating features of storage batteries in connection with fluctuating direct and alternating-current power loads. The electrification of steam roads, and the increasing use of electrical energy in manufacturing plants, where large motors on fluctuating service are used, has necessitated the development of apparatus that will give a flexible control to the battery equipment and make it take that portion of the load, and that portion only, which gives the most efficient results as a whole to the substation or the power plant. Methods have been perfected which practically enable a selective control to be obtained, making the battery take any portion of the fluctuation desired for any predetermined time. For example, a battery equipment can be adjusted by this method to take the top part of the fluctuations only, not beginning to discharge until a predetermined portion of the fluctuation has been thrown on the generator or substation. It can be made to take the lower portion of the fluctuation, stopping at any desired point; or, further still, it can be made to take the first swing of the fluctuation, and then gradually throw the additional load caused by the fluctuation, up to any desired point, on to the generator or substation. With this apparatus any combination can be made to suit the capacity of the generating or rotary capacity with their overloads, so as to give the best net result to the system. This development of battery regulation is especially suited for such loads as are found in steel mills, the hardest kind of service for electrical apparatus which I believe exists.

It should be noted here that the storage battery is constantly adding to the consumption of electrical energy through its use in vehicles of all kinds. Such batteries, charged directly from the circuits or through the intervention of mercury arc rectifiers and motor-generator sets, are numbered by thousands, and the income to the stations from this source is already large.

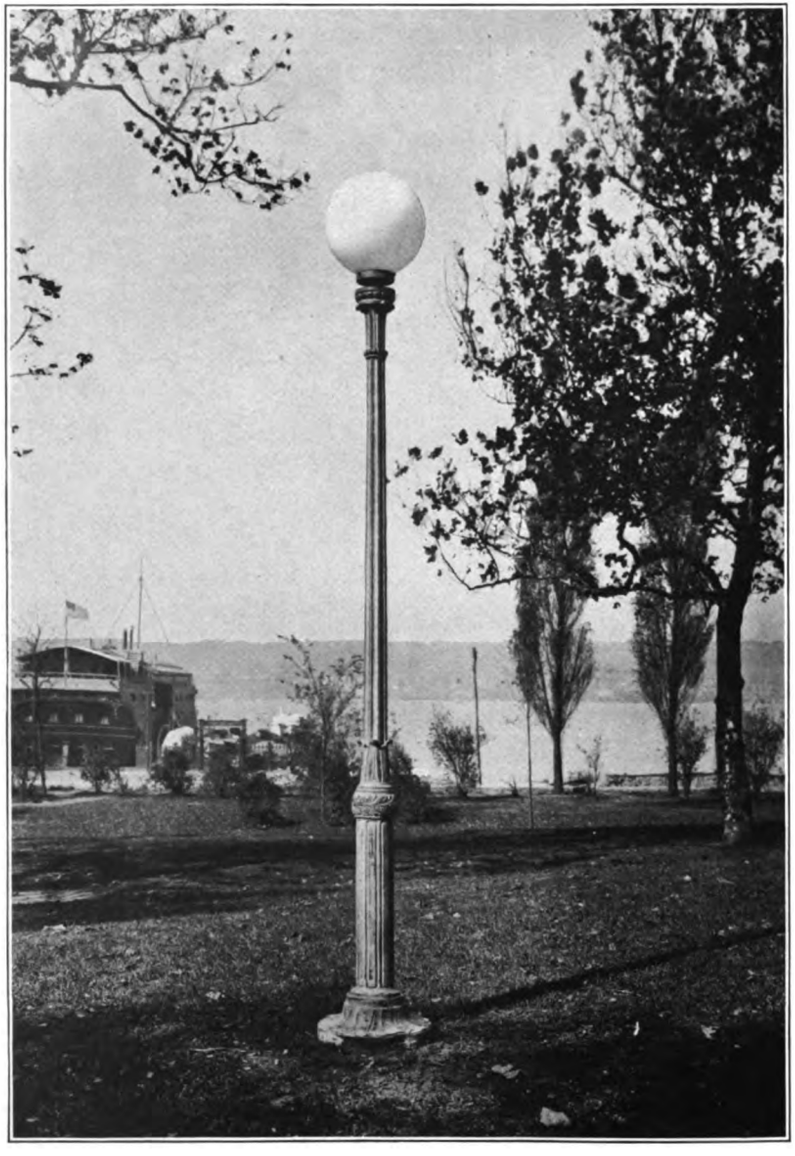
Arc lamps.—A very full account of the development of modern arc lamps up to 1907 will be found in the last census report on the manufacture of electrical apparatus, Bulletin 73. But the subsequent development has been very rapid and new types continue to be evolved. The nature of some of these changes has been quite fully discussed in Chapter IV, and the figures given there indicate the extent to which the old form of open arc was superseded by the inclosed type during the period 1902–1907. The evolution now going on is in the nature of a partial reversion to the open arc, and the abandonment of the inclosed, for outdoor service, while an intensified rivalry with new metallic filament incandescent lamps promises further advances in the direction of economy and efficiency.

The resort to "flaming arcs" has been one of the most noteworthy and spectacular of the changes which the mere figures do not bring out, such lamps being adopted not merely for advertising purposes but for ordinary street illumination. Newark, N. J., affords an example that is strictly new and up-to-date in the special illumination of South Broad street with flaming arcs. This thoroughfare is no less than 100 feet wide, and the merchants on it were keen to secure more patronage. They formed an improvement association and have carried out an agreement with the Public Service Corporation, under which the city makes an allowance to the merchants equal to the sum paid to the company for the former inclosed arcs on the street. A system was laid out of permanent flaming arcs and of special supplementary incandescent lighting for the first two weeks. The arcs, of which there are 35, replacing 21 alternating-current inclosed arcs, are rated at 10,000 candlepower each, and are erected on poles along three blocks of the street, at a spacing of 60 feet. The new installation has been put in on a three-year basis of contract under which the lamps burn from dusk to dawn. The plan was such a brilliant success in all respects that steps were immediately taken to add two more blocks with an additional 15 arcs.

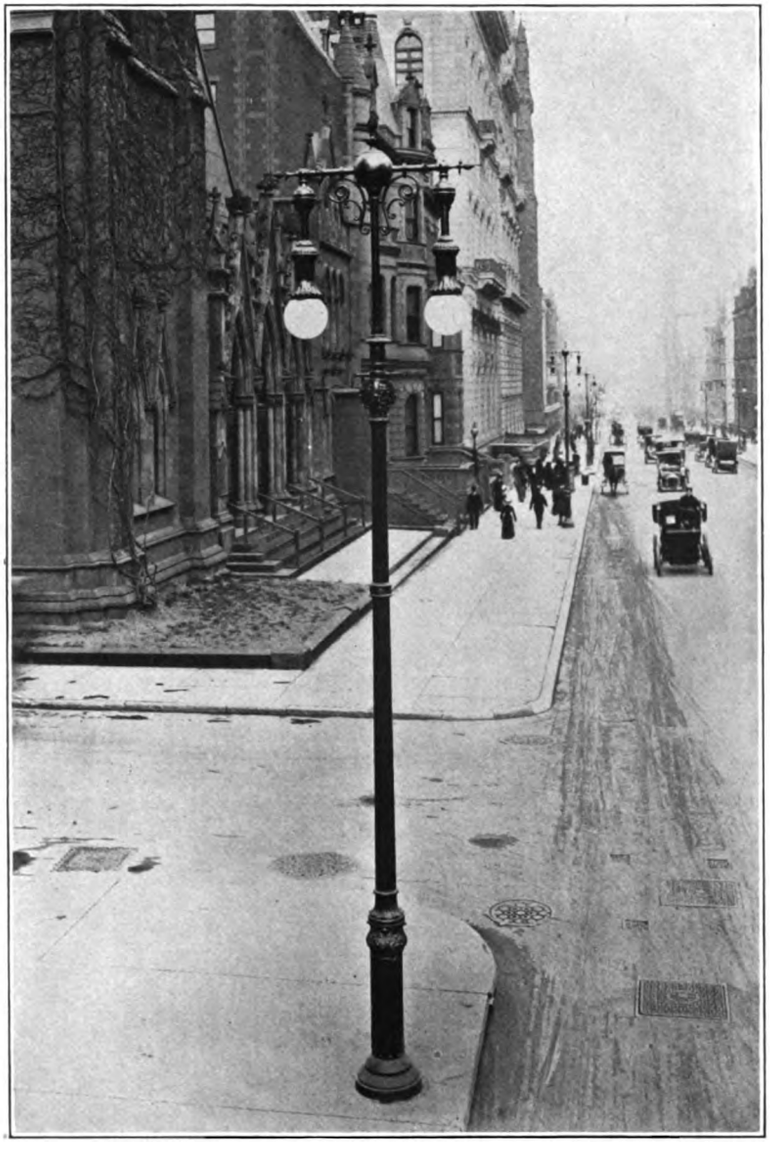
Flaming arc lamps are now being specified by engineers for municipalities and industrial-plant lighting, and naturally the question of maintenance cost is of prime importance. Two distinct types are now on the market, namely, the differential lamp and the so-called "gravity-feed" lamp. The differential lamp is generally adjusted to operate two lamps in series on 110-volt circuits, taking 10 amperes for the series, whereas the gravity-feed lamp, as a rule, is adjusted at 11 or 12 amperes. The differential lamp being taken as an example, the consumption of each lamp is 550 watts, which at an average cost of 2 cents per kilowatt-hour makes the cost $11 per 1,000 hours for current. The net cost of flaming arc-lamp carbons being taken as an example, the cost per trim per 1,000 hours, including labor, would be $8.50, making the total cost of trim

[1] Proceedings, National Electric Light Association, 1909, Vol. I, p. 195.

Digitized by Google



TUNGSTEN LIGHTING, RIVERSIDE DRIVE, NEW YORK CITY.



INCLOSED ARC-LIGHT LAMP-POSTS, FIFTH AVENUE, NEW YORK CITY.

Digitized by Google

Digitized by Google

and carbons $19.50 per 1,000 hours. The cost of repairs and globes per 1,000 hours may be figured at $2, to which $2 per 1,000 hours must be added for interest on the investment and depreciation, making a total of $23.50 per 1,000 hours of operation. At an average yearly operation of about 4,000 hours the cost would be $94 per year per lamp.

For municipal lighting the general plan of installing these lamps is to mount two lamps on one pole, as it simplifies the wiring problem over the plan of mounting one to a pole. The height of the lamps above the sidewalk should not be less than 25 feet, so as to secure a good distribution for their high candlepower.

At the annual convention in August, 1908, of the Ohio Electric Light Association, Mr. C. R. McKay, of the Toledo Railways and Light Company, read a paper in which he described an installation of 1,670 luminous magnetite arc lamps in regular service for street lighting at Toledo, Ohio. All the street lighting in Toledo is now done by means of such lamps, which for the most part are spaced approximately 600 feet apart in the residence and outlying districts of the city. In some other parts of the city, such as the principal shopping district, two lamps are placed on each pole and the poles are spaced 80 feet apart opposite to each other on each side of the street. The energy is generated by 25-cycle, 3-phase turbo-generators. To supply the arc lights, 37 constant-current transformers wound for 2,200 volts primary are installed, together with a corresponding number of mercury arc rectifiers and switchboard panels.

The lamps are generally hung over the center of the street intersections, at a height of approximately 25 feet, by means of suspension wires, and are lowered for trimming. The light in this type of lamp issues chiefly from the long arc itself rather than from the positive crater. It is therefore quite sensitive to rupture by drafts of air unless thoroughly protected by wind-proof casing and tight globes. Early difficulties with the upper electrode have been remedied by using copper of large diameter. The life of the lower electrode has been increased from 110 to over 160 hours. The lamps average from 320 to 324 watts per lamp, including line losses, as measured at the direct-current circuit terminal. The current is about 4 amperes. They take 38 per cent less energy per lamp than the 7.5-ampere alternating-current lamps they displaced. The residents of East Toledo gave unmistakable testimony to the superiority of the luminous arc over the 7.5-ampere inclosed-carbon arc, by objecting publicly to the use of the latter during a temporary interruption of the other circuit. The 1,670 lamps, distributed over 37 circuits, are trimmed by three trimmers, each provided with a horse and buggy. About 1 per cent of the lamps are usually in the shop for adjustment or repairs.

An interesting and novel feature of arc work is the "regenerative" inclosed flame, intended for streets and open spaces. If an ordinary flame arc were inclosed, the heavy fumes evolved from the impregnated carbons would soon form a deposit on the globe and obscure the arc. In this new lamp special means are provided for obtaining a circulation of the gases past the arc, and the light is produced mainly by raising such gases to the temperature of incandescence, and not merely by the combustion of chemicals in the arc. The spectrum of the light is a band-and-band line spectrum, which shows that the gases are in various stages of incandescence. About 15 grams of the associated composition are volatilized every hour, the gases rising from the positive crater through the arc. The lower carbon, which is the positive, is held in a fixed support. Surrounding the arc is a clear-glass cylinder, and outside this again is a translucent globe. The inner glass cylinder is in communication with two metal tubes, one on each side of the globe. There is a circulation of the hot gases up the central cylinder and down the other tubes, and the incandescent gases are carried around and subjected to the high temperature of the arc several times before finally condensing and settling in the outer tubes. The inner glass cylinder is kept perfectly clear of deposit for the greater part of its length, chiefly by the high temperature which prevents the gases condensing, but also probably by the strong direct draft past the arc. The upper negative carbon is an ordinary high-grade carbon. The lower stick is also of high-grade carbon, but is star-shaped in section. The grooves between the eight rays of the star are filled with the chemical composition, which is laid in in the form of a paste. The rods are then baked, and the paste expands into the pores of the carbon and fixes itself firmly into the grooves. The life of a single pair of carbons is over seventy hours. The light is of a yellow-white color, but modifications can be obtained by varying the nature of the composition on the positive carbon. The 550-watt size, taking 5.5 amperes at 100 volts, gives a mean hemispherical candlepower of 2,200.

Among the arc lamps in actual service on central-station circuits may be mentioned those with carbons of smaller diameter than usual, the object being to obtain a whiter and more efficient light, as well as its better distribution. Such lamps have a special adaptation to interior use, where they compete directly with incandescent and "glower" lamps. A typical lamp of this character has a lower negative carbon of large diameter, and a pair of upper positive carbons of small diameter, inclined at an angle to each other. The lower carbon is held in a fixed position while the two small upper carbons are arranged to "draw the arc" on starting, and feed downward as they are consumed. The arc is thus centered in one permanent position, making possible the use of a reflector to project the light entirely into the lower hemispherical plane of illumination. The arc is also inclosed by a large globe which restricts the access of air and brings about conditions similar to those which insure the long life of the carbons in an inclosed arc lamp.

Digitized by Google

Modifications in fixtures, globes, transformers, etc., to meet the changing conditions have necessarily been made, but as a general thing the manufacture of dynamos specifically for arc lighting, as in the early days, has ceased. The lamps now derive their supply of current from generators which operate a variety of other devices at the same time.

Incandescent lamps.—Data are given in Table 45 of Chapter IV as to the approximate number of incandescent lamps on the circuits of central-station plants, namely, 41,445,997 in 1907, or an increase over 1902 of 127.8 per cent. A large gain was shown also in the connections to electric-railway circuits, making a total of approximately 45,991,836 lamps connected. The grand total in the country could be given, however, only after ascertaining the data of isolated plants in office buildings, factories, steamships, and other similar private establishments, and such figures it is impracticable to obtain. Some authorities have assumed the connected lamps of such plants to equal in number those of the central stations, which seems rather improbable; but even if they do not, the total of consumption, assuming each lamp to be renewed once a year, is enormous.

A discussion of many features in the development of the incandescent lamp during the period will also be found in Chapter IV. Attention is there drawn to the nature of the data relating to lamps of 32-candlepower and 16-candlepower, the latter being the standard size. The introduction of metallic-filament lamps and other types has changed the importance and universality of such units, but the heterogeneity prevalent at the time of this report will doubtless settle down again to a limited number of standards by 1912, the probable year of the next electrical census. The varieties of one kind and another now run literally into the thousands, adding seriously to the cost of manufacture and carrying in stock, and it may be questioned whether the consumer is benefited in the end, by an illimitable freedom of choice, which often affects the construction of fixtures and the conditions of the supply circuits. What is involved in the transition may be inferred from the following comment:[1]

So many conditions are involved in a change from one set of fundamental apparatus to another, the period of transition must necessarily be long even if the expected improvements make good. The era of electric traction is well begun, but the steam locomotive, and even the horse car, still prevail. As a matter of fact, it is more interesting and practical to watch the actual incipient changes than to speculate on the possible scope of a whole revolution. For instance, there is an indication that a change in the art is upon us in the scarcity of old-style standard 32 and 50 candlepower lamps, due to the fact that makers are getting ready to discontinue their manufacture. The lamp manufacturers announced their intention some time ago of discontinuing the manufacture of the old common carbon-filament lamps in sizes of over 100 watts because of the advent of the new graphitized-filament lamp now commonly known as the "Gem," which latter, because of its higher efficiency, would be certain to supplant the old standard lamps even if the manufacture of the old lamps was not discontinued. But here comes in one of the prosaic points of detail. The position of the man who has an installation of standard 32-candlepower lamps with standard shade holders and who must substitute the new lamp, which is considerably larger in bulb and longer in neck than the old standard 32-candlepower lamp, is not a profitable one. The new lamp, as made, requires special shade holders when fitted with reflectors. The old standard shade holders leave the shade "high and dry" above the lamp bulb, defeating most of the purposes for which the shade may be intended. If the change to larger bulb lamps requiring different shade holders causes the owner at the same time to change to glassware that is suited to the purpose of most efficient illumination, the change in lamp sizes will have been a good thing aside from all questions of lamp efficiency.

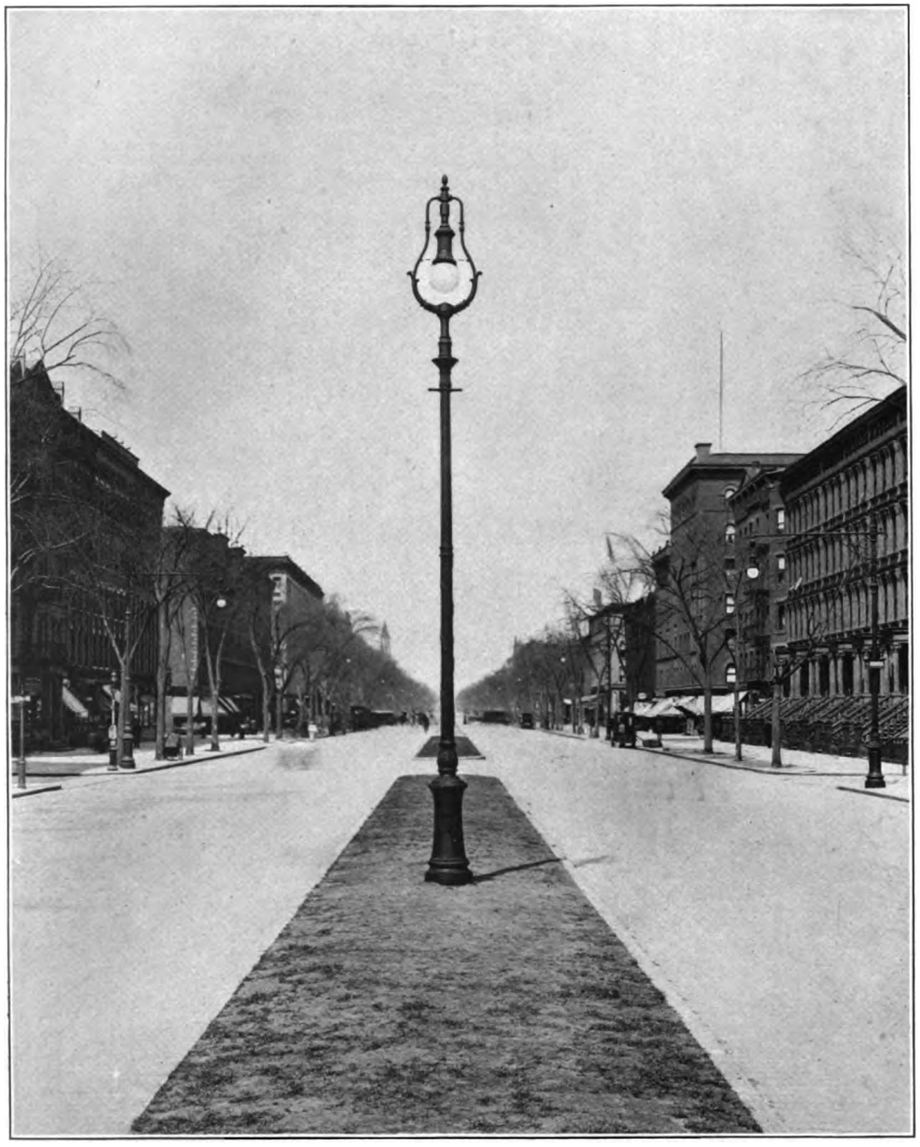
[1] Report of Committee on Progress, National Electric Light Association, 1907.

The departure from the familiar form of carbon-filament lamp and the present popularity of the metallic-filament lamp are well described in a recent article by Prof. Albert F. Ganz.[1] It is pointed out that the early carbon-filament lamps required 5 to 6 watts per candle, but improvements in the manufacture of the filaments had, by about 1888, decreased this specific power consumption to 3.1 watts per candle. The high efficiency lamps, having a specific consumption of 3.1 watts per candle, could, however, be used only on circuits having close-voltage regulation, as otherwise the life of the lamp was greatly reduced. No radical improvements in carbon-filament lamps were made for over fifteen years, until about 1905, when the metallizing or graphitizing process for treating carbon filaments was developed. This process consists essentially in subjecting the carbon filament to the high temperature of an electric furnace with the result that the filament is partly or wholly graphitized. The filament is then "flashed" and subjected to the electric furnace for a second time. The graphitized or metallized carbon-filament lamp, known also under the trade name of "Gem" lamp, has a specific power consumption of 2.5 watts per candle, with the same normal life as the ordinary carbon-filament lamp. A further remarkable alteration produced in the carbon filament by the metallizing or graphitizing process is the change of the temperature coefficient of resistance from negative to positive, so that the treated filament behaves in this respect like a metal. This positive temperature coefficient makes the lamp much less influenced by fluctuations in the supply voltage.

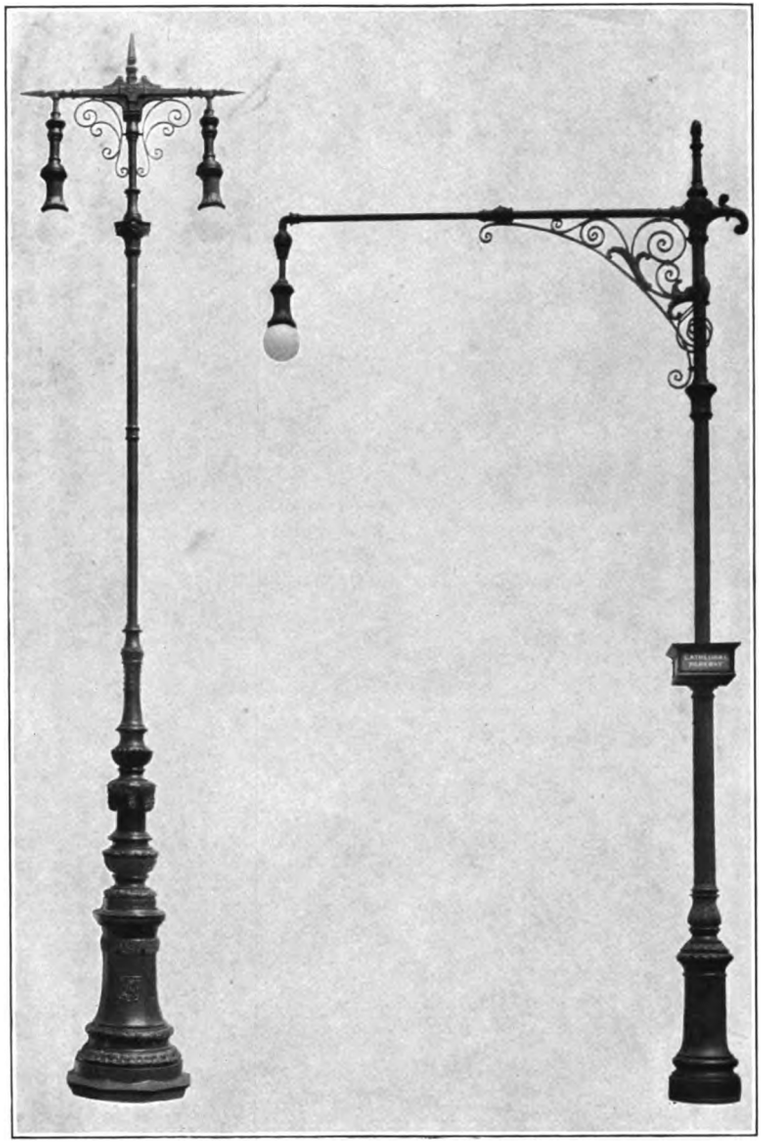
Meantime, incandescent lamps containing filaments of metal and giving efficiencies much higher than could be obtained with carbon have been introduced. Platinum was tried in the early stages of the manufacture, but was found not entirely satisfactory. Osmium was the first metal tried in the newer work, and a fairly satisfactory lamp, having a specific power consumption of 1.5 watts per candle, was obtained. A number of osmium lamps have, in fact, been used commercially in Germany, but the very limited available supply of

[1] American Gas Light Journal, July, 1909.

Digitized by Google



ARC LIGHTING ON SEVENTH AVENUE, NEW YORK CITY.



TYPES OF MODERN ARC-LIGHT POLES.

Digitized by Google

Digitized by Google

this metal has prevented the commercial introduction of this type on a large scale.

About the year 1904 lamps employing tantalum filaments were placed on the market, having an efficiency of about 2 watts per candle, with a useful life greater than that of the carbon-filament lamp on direct-current circuits. Processes were developed for producing pure ductile tantalum which was then drawn into fine wires for use in the lamps, and these tantalum lamps have come into considerable commercial use. A peculiarity of the tantalum lamp is that it has a short life when used on alternating current. The lamp is therefore inherently a direct-current lamp.

The following year incandescent lamps having filaments of tungsten were made in Germany. They had a specific consumption of about 1.25 watts per candle with a useful life claimed to be greater than that of the carbon-filament lamp, and worked equally well on both alternating and direct current. These lamps were quickly introduced on a large scale. The manufacture of tungsten lamps was also started in America about 1907, and they are now rapidly coming into use. Since tungsten is not ductile, the tungsten filaments can not be drawn into fine wires as in the case of tantalum. The production of a filament of tungsten, therefore, presents many difficulties, with the result that several different processes for producing these filaments have been developed. Since the specific resistance of tungsten is very much less than that of carbon, a filament of tungsten for a lamp to be operated at a given voltage must be very much thinner and longer than a carbon filament for the same voltage. For this reason tungsten filaments are admirably suited for heavy-current, low-voltage series lamps for use on constant-current circuits for street lighting. Multiple lamps for 110-volt constant potential circuits are now also manufactured in sizes down to 20-candle-power, but the filaments in these lamps are extremely small in diameter. When the tungsten filament is incandescent it is extremely soft, and the loops, especially those for high-voltage lamps, require supports to keep them in position. The first tungsten lamps were for this reason capable of operating only in a vertical downward position. The lamps have been so improved that they can now operate in any position. The high-voltage tungsten filament is, however, extremely fragile, and liable to break when subjected to vibration, so that these lamps are not yet suitable for places subjected to vibration, as, for instance, on trains or boats. In these latter places, however, the tantalum lamp and the low-voltage tungsten lamp are frequently used.

Both the tantalum and tungsten filaments have a positive temperature coefficient, and for this reason are less affected by fluctuations in line voltage than ordinary carbon filaments. The light given by tantalum and tungsten lamps is also much whiter than that given by carbon-filament lamps, owing to the higher temperature at which these filaments are operated. Another peculiarity of these metal-filament lamps is that they do not depreciate from their initial candle-power until the filament finally breaks. It is at times even possible to repair a ruptured tantalum or tungsten lamp filament by judiciously shaking the lamp with the current on, until the broken ends of the filament come in contact and are welded together by the intense local heat at the point of contact. Such a weld is frequently quite strong, enabling the lamp to continue in service for a considerable time.

The report of the lamp committee of the National Electric Light Association for 1909 brings out some interesting data as to conditions in regard to incandescent lamps in general during the period under review in the present report, based upon data from 200 of the largest central-station companies in the country. It is remarked that as to the general use of different types of lamps, the carbon-filament lamp was still the standard lamp, although the metallized-filament lamps were being used extensively by the companies, more than 60 per cent of those reporting having already used a considerable proportion of such lamps. Several of the larger companies proposed to abandon the standard carbon lamp entirely and furnish the metallized or Gem filament lamps for all their free renewals.

Tungsten lamps had also been in general use, about 75 per cent of the companies reporting that they had used such lamps, and of these in turn fully 75 per cent made extensive use of them and encouraged their introduction generally in their territories. The reports indicate considerable difficulties with the early lamps of this type, but a decided improvement in the later installations. The opinion is almost unanimous that the tungsten lamp is the best possible instrument for making satisfied customers and producing additional revenue. In the matter of incandescent street lighting, a small proportion of the companies reported changes to tungsten lamps, with apparently satisfactory results in all cases.

The number of companies using tantalum lamps was much smaller, about 20 per cent only, and the use of tantalum lamps was apparently becoming more restricted rather than extended. Free lamp renewals was the general practice, except in the case of very small companies and a few of the larger companies. Most of the companies that had furnished carbon lamps on a free-renewal basis were extending that policy to the metallized-filament lamps.

In the matter of delivering lamp renewals, about half of the companies required the customers to send for all lamps; about 10 per cent delivered all renewal lamps upon request of customers; and about 4 per cent made deliveries in accordance with a definite schedule for covering the territory systematically. The other companies encouraged customers to send

Digitized by Google

for lamps, but also delivered upon request, subject to restrictions.

About 25 per cent of the companies making deliveries also placed the lamps in the sockets when requested. About 15 per cent of the companies had their free-renewal lamps marked for identification.

Most companies recognized the difficulty of preventing waste or loss of lamps without placing annoying restrictions upon the furnishing of lamps to customers, and about half the companies reporting kept a record of deliveries to individual customers and attempted, by means of such records, to avoid undue losses.

In the matter of renewing blackened and broken lamps, the general policy seemed to be to refuse to renew broken lamps, but to renew blackened lamps. In the matter of reserve stock, most of the companies carried a safe reserve, which in all the companies reporting would average about two months' supply. The prices charged for other than standard free-renewal lamps varied with the different companies from list prices to cost prices, with, on the whole, little uniformity between the companies.

At the January, 1908, meeting of the Pittsburg Section of the American Institute of Electrical Engineers the physical properties of the various forms of lamps then in use were summed up in the following table presented by Mr. A. J. Sweet:

KIND OF LAMP.	Mean spherical candlepower.	Watts per candle.	Candle per K. W.
Common 56-watt carbon-filament incandescent lamp, rated at 3.5 watts per candle, 16 horizontal candlepower	13.2	4.24	236
Common 50-watt carbon-filament incandescent lamp, rated at 3.1 watts per candle, 16 horizontal candlepower	13.2	3.78	264
3-glower, 264-watt Nernst lamp	81.0	3.26	307
Gem, 125-watt, graphitized carbon-filament lamp of 50 horizontal candlepower	40.7	3.07	326
44-watt tantalum lamp, rated at 22 horizontal candlepower	16.0	2.75	364
Direct-current, 5.1-ampere inclosed arc on 110-volt circuit, 1.5-inch carbons	213.0	2.63	380
Alternating-current inclosed 5.7-ampere arc, taking 388 watts on 110-volt circuit, 0.5-inch carbons	152.0	2.55	392
60-watt, 110-volt tungsten-filament lamp, burning at 1.25 watts per horizontal candle	37.0	1.62	617
Luminous 8-ampere arc, 440-watt, two in series on 110-volt circuit	1,020.0	0.431	2,320

At the March, 1908, meeting of the New England Association of Electric Lighting Engineers, Mr. J. S. Whitaker, of the Rockingham County Light and Power Company, Portsmouth, N. H., read a paper on the introduction of the tungsten lamp. Citing a life test made upon an 80-candlepower, 115-volt lamp, he stated that it burned eight hundred and sixty-four hours continuously, with no perceptible change in color or diminution of light, though no photometer test was made. He instanced a small dry-goods store, which had originally an installation of incandescent lamps and gas arcs combined. Tungsten lamps were installed in the show windows and one wing, on free trial, with the result that an order was placed for a complete tungsten installation. The lighting cost to the merchant for December, 1907, was 20 per cent less than a year before. During seven months Mr. Whitaker purchased 850 tungsten lamps; of these 27 were broken in transit, 418 were installed, and 143 burned out. It was found that 75 per cent of the early "burn-outs" occurred in the first one hundred hours. Later lamps were better and more uniform. A charge of $1.75 each for 100-watt lamps was made to the consumer. This allowed for transportation and breakage. The company replaced all lamps not burning one hundred hours.

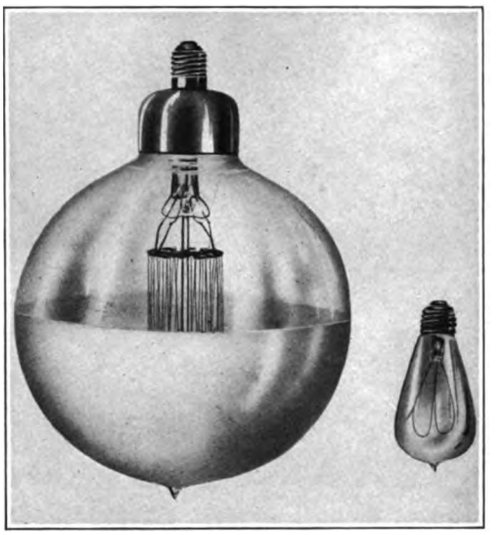
In the discussion Mr. Willcox, of Lowell, stated that a rental basis of 25 cents per month had been found satisfactory in meeting the gas-arc competition. Mr. Sands, of Haverhill, stated that he loaned the shades and reflectors in store installations of tungsten lamps; and if one was broken or lost, the customer paid for it. Mr. Cowles, of the Boston Edison Company, said that his company had installed about 1,200 80-candlepower tungsten lamps, charging an excess of $1.10, the lamp remaining the property of the company. The life appeared to be very good—thus far, at least seven hundred hours. The company placed the lamps in the sockets itself, pendant sockets being used. Mr. Hale, of the Boston company, said that most customers appeared to prefer the lamp installed with a clear shade, even though the company advised the use of a sand-blasted globe and etched shade. In Peabody, Mass., in order to meet gas-arc competition, 100-watt lamps were installed at a charge of $1.50 each, with a guarantee that the annual cost of renewals should not exceed $3 per lamp, which was the yearly rental charged by the gas company. In a bowling alley where formerly there was one gas lamp between each pair of alleys the tungsten lamps were placed, one over each alley, with reflectors adjusted to keep the light out of the eyes of the patrons, and to direct it onto the pins.

It may be added that since the date of the meeting last mentioned, all the points in favor of the tungsten lamp have been improved upon, including longer life, lower price, and less breakage in transit.

The number of cases of adoption of incandescent lamps for street lighting in the period has been remarkable, and the more noteworthy because a great deal of the new work is due to the efforts of merchants doing business along the streets illuminated rather than of the municipal authorities. In other words, it is another example of the stronger public spirit manifested in late years; and it may also be regarded as an evidence of the local pride which seeks to build up the community and its trade. Numerous concerted efforts have been made to enhance by such action the brilliancy and attractiveness of sections of particular thoroughfares or even of whole streets. This development is, moreover, particularly interesting as being in itself an evidence that the general lighting at such points is inadequate. Causing, as it does, too, an

Digitized by Google

TYPE OF ORDINARY TUNGSTEN LAMP.



1,000-CANDLEPOWER TUNGSTEN LAMP COMPARED WITH ORDINARY 16-CANDLEPOWER CARBON LAMP.

INCLOSED ARC LAMP WITH ORNAMENTAL CASING FOR INDOOR SERVICE.

TYPE OF FLAMING-ARC LAMP.

Digitized by Google

Digitized by Google

accentuation of the surrounding gloom, it bids fair to be a factor in raising the general scale of street illumination.

A plan of extra lighting that has now become quite common is seen in arch lighting, of which there are many varieties. For example, Canal street, Grand Rapids, Mich., has been specially illuminated with series tungsten lamps, in 15 spans across the thoroughfare, each with 18 lamps of 60-candlepower, 75 watts. The spans are 100 feet apart, 110 feet in length, and the initial expense was $750 each for labor and material. Merchants paid for the work, and the cost of operation is so small that some of them are at an expense of only $1 per month. The effect has been marked, large crowds have been drawn, and, considered from all points of view, the installation seems to be very successful. On Monroe street, which is about 80 feet wide, 12 arches had been erected, 80 to 90 feet apart, with 14 tungstens on each; and 5 more arches were to follow.

Big Rapids has followed suit and has erected 7 arches, with plans for 5 more. Each arch has 10 tungstens of 60 candlepower in series. Half a dozen other small towns in Michigan have taken up the matter. A popular differentiation from the pipe arch is the stringing of a span wire from pole to pole or from building to building, the tungsten lamps being suspended from the span. It all means additional income for the station, but there are objections made to the "canopy" plan. It puts the lamps up so high that a considerable portion of the illumination is spent on the upper stories of the buildings. The overhead network of wiring is an obstruction to firemen, and there is damage in the case of high winds. The contrasting method of low posts close together has its warm advocates, not merely because of its more permanent character and appearance, but as a revenue producer. Thus, at Minneapolis, the Publicity Club has brought about the lighting of Nicolet avenue, the main street of the city, with 64 standards, 8 to the block, 4 on each side of the street. The cost has been met by assessing merchants $2 a front foot to cover installation and $1.25 a year per front foot for maintenance. The posts are of cast iron, standing 14 feet above the ground, and are ornamental. Each carries four 12-inch alabaster globes and one 16-inch, all in a vertical position, each containing one 100-watt tungsten lamp. The advantages of the vertical arrangement of the lamps are minimum breakage, greater cleanliness, and larger lighting area. Each post is connected to the Edison 3-wire direct-current system of underground lead-sheathed cable. The retail cost of the posts installed is put at $145 each, of which $85 is for foundry work and $60 for wiring, globes, lamps, and similar items. The Minneapolis General Electric Company runs the installation at a total inclusive charge of $78 per post per year. All five lamps are switched on by an electrolier key switch in the post base, and after midnight only the central lamp on top of the post is left to burn until daylight. As compared with a post system installed earlier at St. Paul, these standards are 2 feet higher and have arms 2 feet longer, while the tungsten lamp has added appreciably to the effective result obtained.

At Aurora, Ill., a somewhat similar scheme has been carried out, but there the tungsten lamps are carried in the downward burning position, except the central 60-watt one. No fewer than 173 posts have been installed, each carrying 3 lamps, except at each of the four corners of street intersections, where 5 lamps are used. The posts are 50 feet apart along each side of the street, on the curb line, one arm extending over the sidewalk, the other over the roadway. The plan originated with business men on the west side of the city, who organized the West Aurora Improvement Company. Proper ordinances were passed by the city council whereby the merchants could install and pay for the system and then turn it over to the city for maintenance and operation. Similar movements were started in other parts of the business district, and have culminated in a thorough lighting of the downtown section of the city. It is interesting to note that Aurora, in 1881, began at the other end of the methods of street illumination, with seven 150-foot towers, each carrying two large open arcs, high in the air, where they were imagined to give a "diffused moonlight," most of which in summer time at least, was intercepted from the sidewalks and roads by shade trees.

During the past four or five years there has been considerable advance in the use of electricity for the lighting of public parks, especially since the introduction of the tungsten lamp. In 1908 the New York Edison and allied companies developed a system of park lighting with tungstens and soon after placed large numbers of them in Riverside Park, on Riverside Drive, in Highbridge Park, and in St. Nicholas Park. These lamps are carried on ordinary posts at a height of over 10 feet from the ground. The lantern consists of three hinged interlocking sections, which provide socket and globe-holding devices, with means to clean and replace the lamps quickly as well as the reflectors and globes. To reach the posts, conduit and buried cable have been employed. The service switches control from 16 to 40 units equally balanced over the 3-wire network, and with slight modifications the system could be adapted to series alternating supply when used with a series transformer in either an arc or incandescent circuit. More recent modifications of this service include the lighting of Central Park with tungsten lamps.

In regard to street lighting it is interesting to note everywhere a greater interest in the beautiful aspect of the streets by day and night, and a desire not to spoil trees by bad trimming. At Los Angeles, Cal., the permits issued to the public-utility companies have printed on them in large type: "The trees must

Digitized by Google

be trimmed so as to preserve their symmetry," and this has led trimmers to give some attention to the nature of the tree and the peculiarities of its growth. One of the problems of suburban and rural development of lighting has been how to connect up various dwellings without excessive expense and without marring the attractiveness of the streets and foliage trees by pole lines. In some cities there are alleyways that can be utilized, but most cities are without these. At Rochester, N. Y., the Railway and Light Company has met the difficulty by erecting a pole line on the back-yard boundary line; and the other utility companies cooperate in maintaining the system. The company has deeded to it by the owner the ground on which the pole is erected, together with the right of free access at all times, and in turn it places on the streets a handsome type of arc lamp with standard of bishop's crook or swanneck form. In running the mains to these back-yard poles, high-potential lines are taken underground to a transformer in the manhole nearest the street, and thence low-potential circuits are run to a manhole in the street opposite the pole lines, whence they branch and run underground to the end pole on either side. The mains are then brought up through conduit to the cross-arm. Service connections are made to the mains and brought in overhead to the rear of the houses, and the front of the property is left free from unsightly wires and service connections. The pole line extends from block to block, depending on the number of houses connected. No trouble has been experienced in getting the necessary concessions, as the plan is a benefit to the neighborhood.

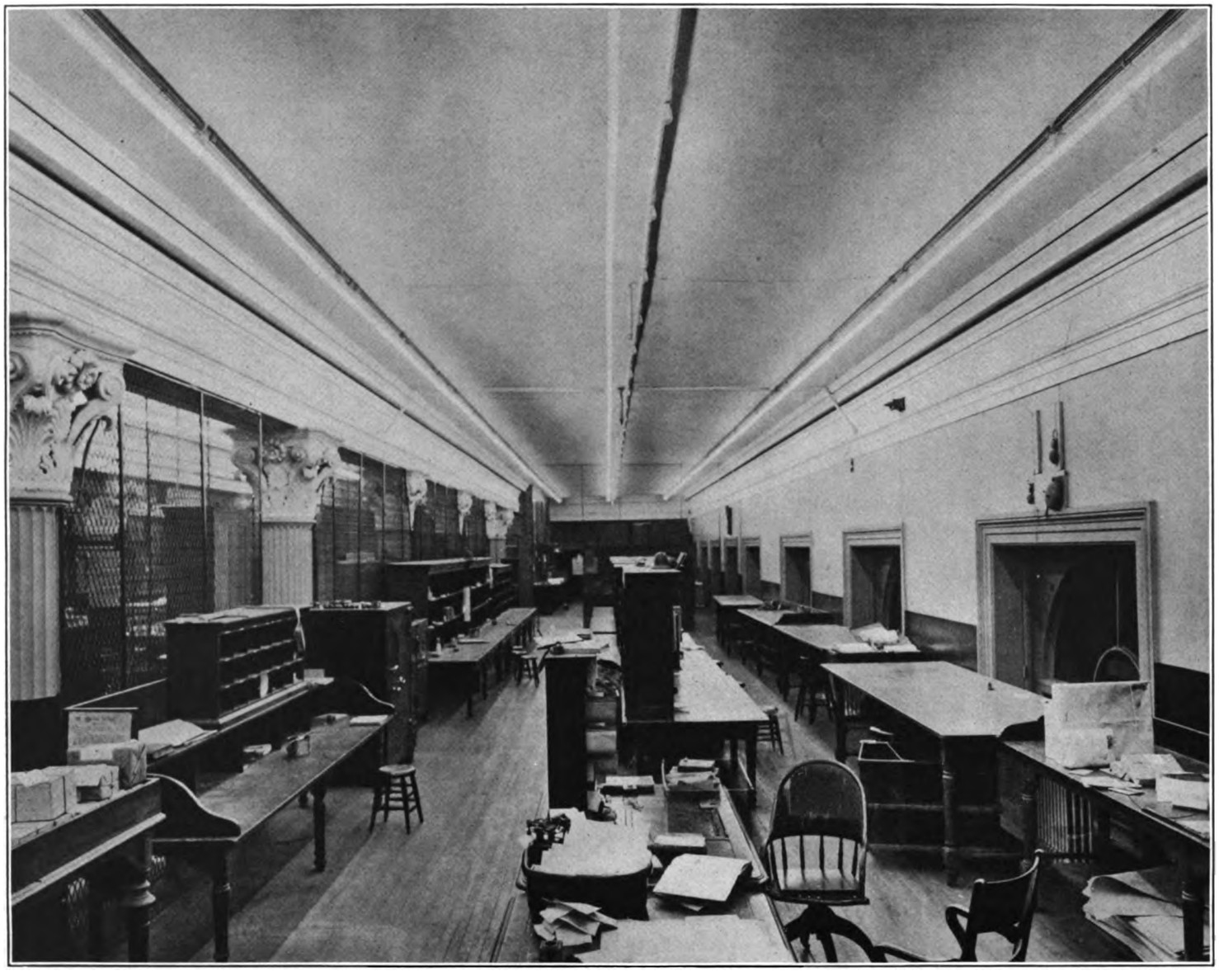
Incidentally the tungsten lamp has already brought with it a number of auxiliary and supplemental devices and methods, such as socket adapters, reflectors, fixtures, and small transformers. In the new ballroom of the Hotel Astor, New York, where 1,200 people can dine or 2,500 can dance at one time, the lighting is done with some thousands of small low-volt tungsten lamps associated with small group transformers receiving current from motor-generator sets. At the twenty-fifth anniversary dinner of the American Institute of Electrical Engineers in the old ballroom of the same house in March, 1909, some 50 large tables were each beautifully illuminated with miniature tungsten lamps fed by a small storage battery set in a low metal vase on each table. Over the battery and lamps was placed a block of glass simulating ice, with a number of holes filled with water in which was set a mass of blush roses and maidenhair fern. The softly brilliant effect obtained would, it is said, have been impossible with carbon-filament lamps. Moreover, it was not necessary to wire each table for local lamps.

An evidence of the activity in the electric-lighting industry is the constant stream of novelties. Of these, the helion lamp is one for which an early commercial perfection is predicted. The carbon-silicon filament of this lamp has been brought to a point where it can be burned in open air at practically the specific consumption of an ordinary vacuum carbon lamp. An interesting quality of the filament is its extraordinary high specific resistance, which is nearly thirty times that of the carbon filament and several hundred times that of tungsten. Particles of it are so hard that they will scratch glass.

The present report includes data as to the extension of the use of Nernst or "glower" lamps. The introduction of the metallic-filament incandescent lamp has by no means operated to eliminate this lamp, which has many desirable features of its own. The vogue of the glower lamp is also due to the fact that new units have been developed, considerably better in efficiency than the old. Coincident with the improvements in the glower came the development of the single-glower renewal screw burner, making the renewal of the lamp the same practically as in standard incandescent practice. This has resulted in the introduction of the screw-burner principle into chandeliers; and the new fixtures of that type are characterized by economy of space and high illuminating power. A number of large stores and other establishments have adopted the glower form of illuminant. The Marshall Field store in Chicago, with 25 acres of floor space, is an example, the details of the lighting of which were made public in October, 1907, by Mr. F. J. Pearson, electrical engineer of the dry-goods company, from which report the following is taken:

Tests of various lighting systems were carried on over a period of eighteen months. While the illumination calculated from the photometric curves of individual lamps, as well as measurements of illumination at the counter level in the actual installations, was made use of in comparing results, far more value was attached to visual tests made by comparing the general appearance of large rooms or sections of rooms lighted in different ways. To show the multiplicity of requirements, it is stated that there were 350 sections in the store, nearly every one of which had a different class of goods, and therefore presented somewhat different requirements. It was therefore necessary, if uniformity throughout the store was to be secured, to select a compromise system which would meet fairly well all requirements. The general plan of testing the different illuminating systems offered by the different manufacturers was to take a large room about 150 by 250 feet, and equip one-half of it with one lighting system and the other half with another. This was thought to be the best way to bring before the non-technical public and the sales managers the relative effects and efficiencies of the various systems. Glower lamps on short chain pendants were finally selected for lighting the establishment, with an average illumination in the foot-candles as follows: All above the first floor, 2.5 to 3; the first basement, 3.5 to 4; second and third basements, shipping and packing departments, 2.25 to 2.5. Arc lamps were not seriously considered,

Digitized by Google



ROOM IN NEW YORK POST-OFFICE LIGHTED WITH VACUUM TUBES.

Digitized by Google

Digitized by Google

because it was stated that not 10 of the 350 section managers wanted to sell goods under them. The selection of the glower lamp was made because of low maintenance cost, color, and good general effect, as indicated by the preference of the management and the section managers.

The Moore tube system of vacuum lighting has also made progress, not only in the design of apparatus, but in the use of the tubes when provided with carbon dioxide, and is valuable in business establishments where color values are a main consideration. The long-loop tube system has been standardized into a "hair-pin" form, and there has also been developed a "straight-run" form, i. e., one end of the tube does not reenter the terminal box. The entire mezzanine floor of the New York Post-Office has been very successfully fitted up with tubes in 35 parallel rows, each 114 feet long, placed immediately against the ceiling.

Where the peculiar color is not objectionable, a large amount of miscellaneous lighting has been done with the mercury vapor lamp, which was in 1901 introduced to public notice by Dr. Peter Cooper Hewitt. He has since developed the same principle in the mercury arc rectifier, now also used largely to rectify alternating current into direct for various services, and especially for charging storage batteries. The lamp is a glass tube about 1 inch in diameter, on 110-volt circuits about 4 feet in length, and the light is obtained by vaporizing with the current the small quantity of mercury that the lamp holds. Dr. Louis Bell gives a specific consumption of 0.6 to 0.8 watt per equivalent candlepower for these lamps. The light is practically without red rays, but is strongly actinic and is therefore largely in use for photographic purposes. Mercury vapor lamps have been constructed with tubes bent into a circular form, so as to fit in a diffusing globe, and in some cases incandescent lamps have been added in the fixture for the purpose of supplying the red rays missing in the mercury vapor light. A prominent example of commercial lighting by units combining a mercury vapor lamp with a tungsten incandescent lamp is found in the editorial offices of the New York World, where 36 such units have been in use since May 1, 1908. Each combination consists of a mercury vapor tube bent into circular form of about 10 inches diameter, with a tungsten lamp in the center. The vapor tube and tungsten lamp are attached to an ornamental metal fixture provided with a white corrugated reflector and surrounded by a 16-inch holophane hemispherical globe. The combination lamp is designed to operate on the 120-volt circuit, and to take a current of 2 amperes, thereby consuming 240 watts. The vapor tube and tungsten lamps are connected in series, the vapor tube taking about 52 volts and the tungsten lamp about 58 volts. The remaining 10 volts are taken up by steadying inductance. An automatic device consisting of an inductance coil with a quick mercury break in vacuum, called a "shifter," is placed in the fixture for starting the lamp. Tests of the illumination produced by this installation, made by means of a luminometer, and of the power consumed, show that the candlepower of the tungsten lamp is about 80 and of the vapor lamp about 200. With a power consumption of 240 watts, this gives an equivalent specific power consumption of 0.86 watt per equivalent candle.

The quartz mercury vapor lamp has also become a commercial success and is in use in Germany. Its formidable powers of competition may be inferred from the fact that with the mercury arc playing in a quartz tube it is possible to raise the temperature very much higher than can be done in a glass tube. The maximum is reached at about 1 watt per candle, and afterwards the specific consumption decreases rapidly down to about 0.16 watt per candle.

Electric power.—As the statistics show, the intercensal period witnessed a phenomenal development in electric-power supply, or motor service. If it were not for their motor day load, many central-station companies would doubtless find themselves in difficulties. One problem, of course, is to prevent overlapping of the lighting and the motor loads, and this has been worked out in one way under the Gossler system as adopted in Montreal, Canada, and in various cities of the United States. In 1894 the Royal Electric Company of Montreal was supplying the equivalent of 14,700 16-candlepower lamps and 50 horsepower in motors; while the total number of its customers did not exceed 300, and none of the various heating appliances were heard of. In 1907 the Montreal Heat, Light and Power Company had connected to its system the equivalent of 450,000 16-candlepower lamps, about 37,000 horsepower in motors, and upward of 1,000 appliances for heating, cooking, refrigerating, and so forth. The company served upward of 13,000 consumers of electricity and about 50,000 consumers of gas, or a total of nearly 70,000 consumers. The nonpeak users under this system are encouraged by a special concession of rates. It was found that about 40 per cent of the company's customers could be shut off from obtaining energy at the time of peak load without detriment to them. Among the loads were 3,500 horsepower in cotton mills, which in order to obtain the concession start operation at 7 a. m. instead of 8, allow only half an hour for lunch, and are thus able to stop work at 4.30 p. m. The operatives in many instances prefer to work during these hours and go home early than to begin later and finish later. Among the off-peak customers were the various morning and afternoon newspapers, to which the company supplied upward of 400 horsepower. Another class of customers were the brickyards, which required a summer service exclusively, and secured a 50 per cent reduction from the regular rates on seven months' operation. The amount of horsepower involved was 600 to 700, used in driving casting machines, mixers, and

Digitized by Google

conveyors. Other nonpeak users were the local water-power company, which used 1,200 horsepower in pumping drinking water; a railway-appliance company, which used 500 horsepower; cement works, which in 1909 used from 5,000 to 6,000 horsepower; and various wood yards. In the wood yards all the cutting was done during two or three hours of each day. The nonpeak rates were given to customers consuming relatively large amounts of power. An installation of 20 to 25 horsepower would be about the limit below which the nonpeak rate would not be granted. Extensions of the system have been carried out since the above data were obtained.

The extent to which electrical energy is now sold for power purposes is illustrated by the railway contracts made by the Commonwealth Edison Company of Chicago, which has been particularly energetic in reaching out for this class of business. Under the ten-year bulk contract with the Chicago City Railway, for example, the energy is supplied by the power company to the railway company in the form of a 3-phase, 25-cycle, 9,000-volt current. The railway company pays a minimum, primary, readiness-to-serve charge of $1.25 per kilowatt of demand per month. The kilowatts demanded are taken as 21,000 as a minimum for the first year of the contract and as much more as may be demanded. For the remaining nine years of the contract the railway company pays according to the following provisions for determining the maximum demand: The railway company's maximum demand in kilowatts for each month, upon which the primary charge is made, is determined by taking three consecutive days in the month, out of which there are selected two hours, of which one is the hour of greatest output in kilowatt hours in the first half of the day and the other the hour of greatest output in the second half of the day. The combined output for the six hours selected in the manner thus indicated must be greater than the combined output of six hours similarly selected from any other three consecutive days in the month. One-sixth of the aggregate number of kilowatt hours consumed by the railway company during the six hours selected is considered as the number of kilowatts constituting the railway's maximum demand. If the railway's maximum demand exceeds 21,000 kilowatts during the first year, the railway is to pay $1.25 per kilowatt of demand for each month for all in excess of the amount named.

The applications of electric motors on central-station circuits are now so numerous that it is useless to attempt to enumerate them all. The motors find employment in every industry and have seriously modified methods in some classes of work. A notable instance of their use outside of manufacture is furnished by the electrically operated high-pressure water systems for fire protection in the boroughs of Manhattan and Brooklyn, New York, for which the city appropriated over $5,000,000 for the whole work. The pumps are operated by induction motors, the aggregate rating for those installed in the four stations being 15,000 horsepower. Either salt or fresh water can be used, although up to the present time only the latter has been admitted to the mains. The systems are very extensive, that on Manhattan Island comprising about 63 miles of mains varying in diameter from 12 to 24 inches. The five pumping units in each station will deliver 5,000 gallons per minute against a discharge head of 300 pounds per square inch when operating at 750 revolutions per minute, with a suction lift not exceeding 20 feet. The pumps can be brought from standstill up to full speed in thirty seconds; and the company is under a contract penalty of $500 per minute if it fails in three minutes after an alarm is given to furnish the proper and adequate motor service. The readiness-to-serve charge is $24 per year per kilowatt of the kilowatt rating of the motors and 1½ cents per kilowatt hour for energy actually used.

The Brooklyn Edison Company receives $3,660 per month for its readiness to serve and 1½ cents per kilowatt hour for current used. The cost of the two Brooklyn stations and equipment was about $300,000. The interest on the city investment and cost of maintenance will approximate $78,000 yearly, while the reduction in insurance premiums in this borough is placed at $300,000 per annum. It is work like this that gives an idea of the loads that are being taken up to-day by large central-station systems throughout the country; and the $500-per-minute fine does not appall them, so reliable have such systems become.

A special example of the development of motor service from central stations during the intercensal period is found in its use for refrigerating, where the motor drives the localized cooling apparatus and the use of ice is dispensed with. Several plants of this kind are being operated in Philadelphia, ranging in capacity from a quarter ton of ice, driven by a 1-horsepower motor, up to 35 tons, driven by a 75-horsepower motor; and in some instances there are several units in the same plant. During 1907 the connected load of this character on the circuits of the Philadelphia Electric Company increased 217 per cent, represented by over 230 ice-tons capacity of refrigerating machinery. In the year named the company was operating refrigeration machines in saloons, grocery stores, residences, drug stores, dairies, butcher shops, and restaurants, and it has since added to this list the establishments of florists, candy makers, ice-cream makers, fish and game dealers, pork packers, hospitals, bottlers, and fruiterers, and the equipment for cooling drinking water in office buildings. The yearly bill has been found to vary from 4.3 to 9.2 times that for the highest month and from 5.5 to 14.8 times that for the month of June. This relation is modified somewhat by the differences in temperature of the different localities. Electricity is also employed to operate brine pumps and deep-well pumps, and the auxiliary-motor service

Digitized by Google

of this kind connected in 1907 showed an increase of 284 per cent.

Early in 1907 one of Philadelphia's leading firms of florists decided to adopt mechanical refrigeration. They had a display case 16.5 feet long, 9 feet high, and 42 inches wide, embracing about 500 cubic feet, with three shelves, drawers below, and an ice bunker above. The flower jars and vases held probably 200 to 300 pounds of water, which was renewed daily. Four 16-candlepower lamps, placed so as not to be seen by the observer, were kept burning in the case above and in front, in order to illuminate the display properly. Openings in the floor of the main case permitted the cold air to circulate down to and around the smilax and other green stuff kept in the drawers below. Both doors and drawers were opened frequently, averaging probably four times per hour each. Under these conditions it was found necessary to use 500 to 700 pounds of ice each day to maintain a temperature of 44 or 45 degrees. The annoyance and inconvenience of handling were great, and the ice bill for one year was $501. A 1-ton plant driven by electric motor was installed at a cost of $1,000, and the first year's saving direct was $34.

Refrigeration suggests ventilation and the motor fan. Central-station companies have generally ceased to make any attempt to enumerate the fans on their circuits, though in some cities the figures are kept. In 1908 the companies in New York City reported that they had about 250,000 fans on their circuits, which furnished an appreciable and profitable day "load" during the summer months. The Philadelphia Electric Company estimated the number on its circuits at about 10,000, and a summer income from them of more than $20,000. St. Louis claimed at least 10,000 on central-station circuits; Providence, 5,000; Buffalo, 2,000; and Denver, 1,500.

The automobile load is a class of business in which, more or less directly, the modern central station supplies current to motors, several thousand machines now being operated by charging from the circuits. A typical example of what can be done is found in Toledo, Ohio, where the Railways and Light Company makes a charge of 3 cents per kilowatt hour to all public garages and repair shops, and 5 cents to private individuals, or a minimum bill of $3 per month to both classes. The result is that in Toledo there were in 1908 about 500 electric automobiles, and 9 public garages and 85 private ones using electricity. The company sold mercury arc rectifier sets at $230 for 30 amperes, including installation, and made a reduction of $20 when the owner installed the rectifier himself. The rectifier is said to cause an average reduction of about 40 per cent in kilowatt hours consumed as compared with charging through a rheostat. The income to the company was about $48 per year per vehicle in use in the city. One of the garages in the city could charge 48 vehicles at once, and 60 to 75 were charged by it in a single night. Its rates were $22.50 per month for charging, keeping, washing, and delivering an electric coupé. Another garage had some 80 vehicles on its regular list. It charged $20 per month for keeping up an open vehicle and $22.50 for a closed one.

Electric heating and cooking.—Great advances were made during the intercensal period 1902–1907 in the arts of electric heating and cooking, although the present report is practically without data of a statistical character in regard to the extent to which the various devices for these purposes have found a place on central-station circuits. For many years such apparatus was costly, easily deranged, and very uneconomical in its consumption of current; but these defects have been removed. While electric heating and cooking can not yet compare in general cheapness with older methods, including the use of gas, electricity has already made a place for itself in innumerable special instances and over a wide variety of industrial and domestic work. Moreover, the high efficiency metallic-filament incandescent lamps, by their smaller consumption of current, have put central-station managers on the alert to dispose of the surplus plant and electrical energy thus left idle on their hands. As a result there has been a really enormous stimulation of activity in this newer field. The progress that is being made may best be ascertained from the statements of some of the central-station operators who have studied the novel problems involved. One great advantage of electrical apparatus of this class is that it can be used with equal success on either direct or alternating current. It needs only to be fed with the proper amount of current from the supply circuits, without any particular adjustments except those for protection against fire and other accidents.

At the Ohio Electric Light Convention, held during the summer of 1907, Mr. M. E. Turner gave some interesting data about the use of electrical apparatus for cooking in Cleveland. He stated that it was not possible to obtain complete figures from all users, but the following reliable data were collected from 11 homes using complete cooking outfits:

ELECTRIC COOKING.	Number of residence.	Full months of use.	Average number of people cooked for.	Average kilowatt hours used per month.	Average per month per person.
Total, exclusively and in part	.....	.....	62	1,209	20
Exclusively	1	11	7	237	[1]34
Exclusively	2	6	3	85	28
Exclusively	3	5	3	62	[2]21
Exclusively	4	2	7	171	24
In part	5	1	3	34	11
In part	6	2	5	47	9
In part	7	2	7	68	10
In part	8	2	4	40	10
In part	9	4	6	34	6
In part	10	5	8	360	45
In part	11	1	9	71	8
Total exclusively	.....	.....	20	555	28
Total in part	.....	.....	42	654	16

[1] Includes laundry ironing and water heating.
[2] Includes laundry ironing.

Digitized by Google

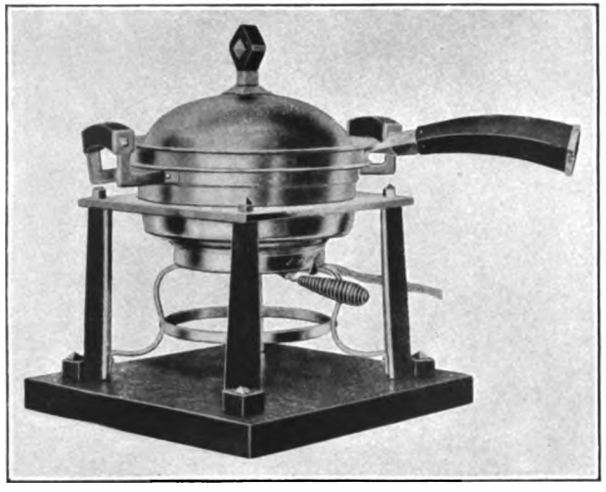
These figures indicate that with the growth of this branch of the business an increased energy consumption of from 100 to 200 kilowatt hours per residence per month may be expected. In Cleveland a two-rate method is used for billing residences, and the users of electric heating generally received the benefit of the secondary or lower rate. In fact, the cooking in all the 11 residences cited was done at a 5-cent rate. The expense under these conditions compares favorably with that for manufactured gas, and the fact that over 1,100 electrical-heating devices were sold in Cleveland by the local illuminating company alone during the twelve months preceding June, 1907, illustrates how popular electrical-energy consuming devices were becoming in the home. These sales were made through newspaper advertising and through the efforts of one salesman, and toward the close of the period named over 100 such devices a month were being sold without any direct solicitation. The results from June, 1907, down to the date of writing are equally striking.

At the meeting of the Northwestern Electrical Association in Milwaukee during the spring of 1908, Mr. E. I. Callahan presented the advantages of an electric-heating load, and suggested some methods of securing it. He knew of no easier way by which companies could secure the desired result of getting more revenue with existing investment than by pushing the use of heating devices. Many of these devices, he claimed, were simple enough to be used in nearly every room in the house, by anyone, and could be connected to the usual receptacles provided. The central stations could usually supply 75 per cent of the load demand without providing increased transformer, meter, or plant capacity. He suggested that central stations not operating day circuits follow the example set by several managers, and for a trial start day circuits to operate all day on Tuesday, ironing day. Small motor loads would then spring up and the plants would soon be forced to operate every day in the week. As to soliciting business, he suggested that personal solicitation, although the most expensive advertising, was by far the most productive. He gave the results of cooking by electricity in his own home, in which for a period of a year the watt hours per person per meal averaged 264, with a maximum demand of about 2.8 kilowatts. Mr. J. R. Cravath, from his own experience, confirmed these figures, and stated that his maximum demand was about 3 kilowatts, inclusive of ironing. Mr. Korst, of Janesville, Wis., stated that about half of the residence customers of his company had flatirons, and that a very good revenue was derived from this source, especially during the summer months. He found, however, that when the bills crept up in the winter time, customers were apt to use their old irons heated on the coal ranges. In the summer many customers' bills, exclusive of the ironing, would fall below the $1 minimum per month. The use of the electric flatiron would bring the bills a little above $1, which would give the company more revenue, and better satisfy the customer because he thereby avoided paying for something he did not get. The flatiron also induced persons who were not previously customers to have their houses wired. Mr. R. N. Kimball, of Kenosha, Wis., said he had at first attempted to introduce flatirons by having a demonstrator in the office, but that he did not get much business that way. The demonstrator was then sent out to canvass the residences, and the results were very much better. Fully 75 per cent of the irons sent out on trial were kept and not returned to the office.

At its Grand Rapids convention in September, 1908, the Michigan Electric Association received the report of a special committee which had canvassed the central stations of the state as to the results obtained with electric heating and cooking. In general, the data as to progress were similar to those given above. Next to the flatiron in popularity and as income earners were the toasters, water heaters, and luminous radiators. Most stations reported the toasters and luminous radiators as equal in popularity, some of them having as many as 150 of each on their lines. The sale of chafing dishes, percolators, heating pads, and other devices seemed to be limited, either by reason of their first cost or infrequency of use.

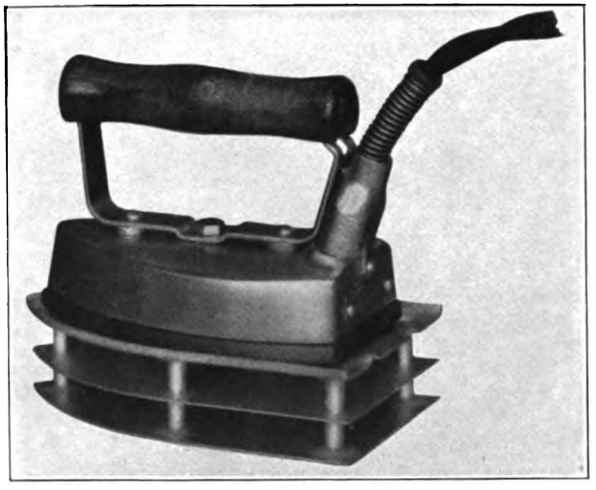
Another field of operations reported on by the committee named was that of the commercial heating of such appliances as gluepots, solder pots, soldering irons, and branding irons. Perhaps the greatest drawbacks to the introduction of electrical devices for the work indicated have been the high initial cost and the frequent burn-outs. Very few of the stations reported any great advances in the introduction of cooking outfits. For this the initial cost of the outfits and devices seemed to be mainly responsible, since even with such a rate inducement as 2.5 cents per kilowatt hour, as established at Sault Ste. Marie, no great amount of business was reported in this line. Other drawbacks to the electric-cooking outfit were its limited reserve capacity for the average family, and the inability of any yet known devices to heat enough water for the average household at anywhere near a reasonable price. The committee thought that before the electric-cooking outfit could be a success it would be necessary to furnish to the public devices that were not only fireproof, but more efficient, longer lived, and of lower initial cost. Tests had shown considerable saving by the use of the fireless cooker in connection with electric outfits, and many of the stations were already introducing and recommending them. Indeed the whole art was declared to be in a state of such rapid transition and improvement that criticisms valid at one time soon become of little weight.

Digitized by Google

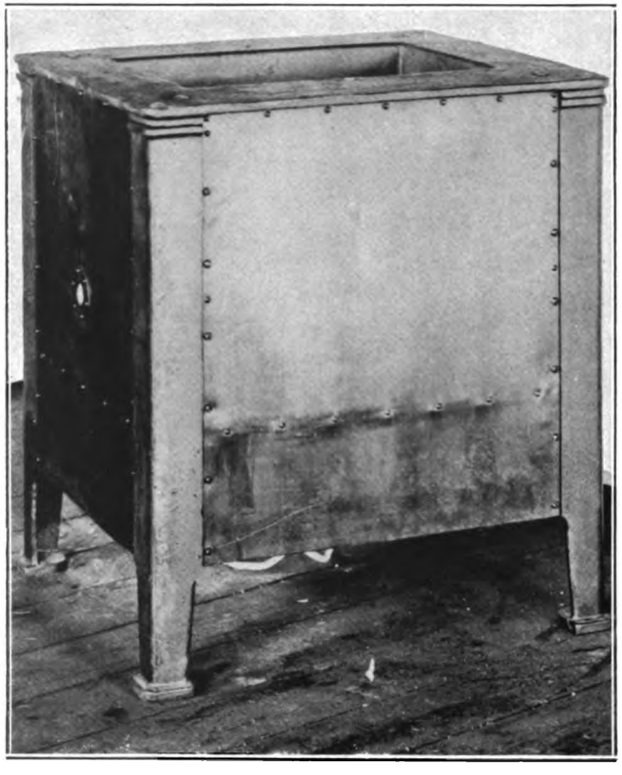


TYPICAL ELECTRIC CHAFING DISH.

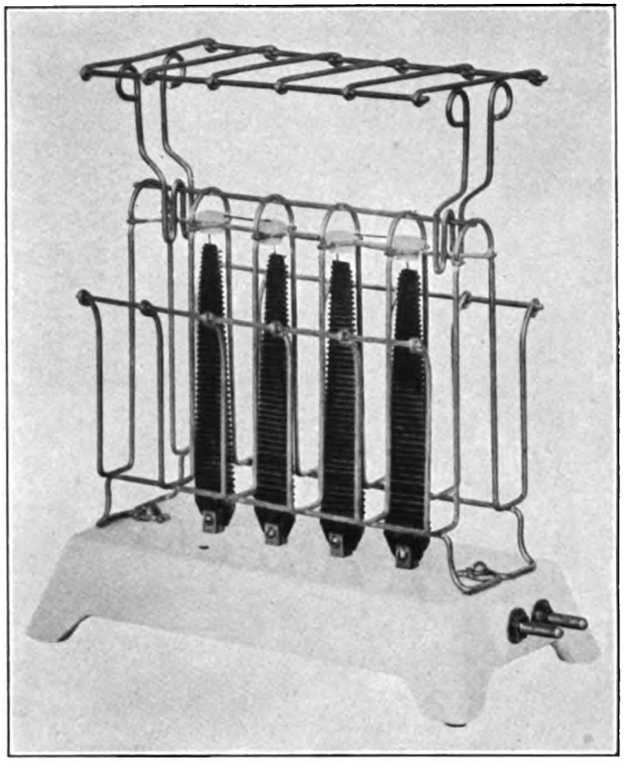
ELECTRIC COFFEE PERCOLATOR.



ELECTRIC FLATIRON.



ELECTRIC OIL-TEMPERING BATH.



ELECTRIC TOASTER WITH WARMING SHELF.

Digitized by Google

Digitized by Google

Electric meters.—According to the data given in Chapter IV on line equipment, there were 1,683,917 meters on central-station consumption circuits in 1907 as compared with 582,689 in 1902, the gain being not less than 189 per cent. If meters on electric-railway lighting systems are included, the number in 1907 was 1,897,803, representing a gain for the intercensal period of 196.9 per cent. Such figures furnish a clear indication of the rapidity with which the old practice of selling electricity on a flat-rate basis is being abandoned. It is true that a great deal of electricity is still sold by rough estimate, at an arbitrary price per lamp per year, or per horsepower of motor, and it is also true that modified flat-rate systems of payment have enjoyed some degree of favor; nevertheless, it is probable that no progressive central station of any size can be found that does not employ customers' meters, and the customers themselves, as a general rule, prefer to buy current that is measured. To show the importance attached to the subject, it may be mentioned that the report of the meter committee of the National Electric Light Association, presented in 1909, was a document[1] of over 300 pages; and to that exhaustive report special students of the subject are referred. The report was based on information received from the member companies, and included descriptive data concerning meters in general use on central-station consumption circuits.

The statistics in Chapter IV do not distinguish between types of meters or attempt to give their capacity. The answers given by the companies showed that some of them are still using the older commutator type of watt-hour meter, as well as the induction type of ampere-hour meter on alternating circuits. It was formerly considered that the commutator type of watt-hour meter was equally suitable for both direct and alternating current circuits; and, indeed, when the meter was properly "compensated," it did register with equal accuracy, in the majority of cases, on both kinds of service. At the present time the commutator type of meter is considered as a direct-current meter, while the induction watt-hour meter is regarded as preferable for alternating-current consumption circuits. It was found that while the ratio of meter capacity to connected load varied among the member companies, yet, considered as a whole, it was not far from 1 to 1—that is, 1 kilowatt of meter capacity is installed for each kilowatt capacity of connected load. It is but seldom that the peak load exceeds 30 to 60 per cent of the connected load and the generators seldom exceed 70 per cent of the connected load. It would appear from the following table that, on the average, the smaller companies had installed about 1.4 kilowatts of meter capacity for each kilowatt of generator capacity:

[1] Proceedings, National Electric Light Association, 1909, Vol. I, p. 257.

KIND OF SERVICE.	METERS INSTALLED.			
	Number of meters.	Average cost per meter.	Average capacity per meter in kilowatts.	Average cost per kilowatt of meter capacity.
Mostly residential	600	$11.75	0.91	$12.91
Mostly business	5,000	13.35	1.69	7.90
General	10,000	14.20	3.06	4.63
General	20,000	13.60	3.46	3.93

Assuming the cost of generators for smaller plants to average $12 per kilowatt and the cost of meters $8 per kilowatt, it will be seen that the cost of meters is not far below the cost of generators.

As an evidence of the effect of improved meter practice upon the average accuracy of meters, and the consequent influence on the revenue, the following table, received from a member company, was presented in the report referred to above. This company, supplying both alternating and direct current, replaced in all direct-current meters the stationary shunts with adjustable shunts, equipped all direct-current meters with diamond jewels, replaced all commutator meters on alternating-current circuits with induction meters, substituted modern meters for many of the older type, and improved its system of testing, with the following results:

YEAR.	Meters in service December 31.	Tenth load accuracy, per cent.	Heavy load accuracy, per cent.	Number of meters tested.	Per cent of meters tested.
1902	3,400	84.4	92.0	1,868	53.5
1903	4,165	81.5	94.0	2,980	71.5
1904	4,952	84.2	95.1	3,556	71.8
1905	5,861	87.9	96.1	4,044	69.0
1906	6,964	90.3	97.1	4,086	58.6
1907	8,060	92.2	97.5	6,942	86.1
1908	9,276	94.1	98.1	10,558	113.8

As indicative of the condition of meters not tested for from two to five years, the following table, showing the results of testing the 192 meters of a small company was also presented:

PER CENT.	LIGHT LOAD.		FULL LOAD.	
	Number of meters.	Per cent.	Number of meters.	Per cent.
Total	192	100.0	192	100.0
Above 20 fast			2	1.0
Between 10 and 20 fast	1	0.5	3	1.6
Between 4 and 10 fast	3	1.6	8	4.2
Between 2 and 4 fast	4	2.1	6	3.1
Between 2 slow and 2 fast	24	12.5	54	28.3
Between 2 and 4 slow	13	6.7	45	23.3
Between 4 and 10 slow	36	18.7	38	19.8
Between 10 and 20 slow	44	22.9	12	6.2
Over 20 slow	18	9.4	5	2.6
Not recording	49	25.6	19	9.9

It is evident from the above tables that the financial success of a company may be vitally dependent upon the testing of its meters, and it is obvious that the consumer has an equally large interest in securing the highest possible accuracy in the apparatus upon which alone the cost of service to him depends.

Digitized by Google

In Massachusetts a customer of an electric-light company or the company itself may apply to the Board of Gas and Electric Light Commissioners for an examination and test of any meter in use, the board furnishing the applicant with a certificate of the result of the test and the expense attached thereto. If the meter is inaccurate, the board may order the company to repair it or substitute an accurate one. All fees for examinations and tests are paid by the applicant, but if the examination is made at the request of the customer and the meter is found to register too fast, the electric-light company is responsible for the fees. The meter is deemed to be correct if it does not vary more than 5 per cent from the standard approved by the board. The inspector employed by the board receives a salary, together with necessary traveling and other expenses. The aggregate amount, however, must not exceed $3,000 in any year. Should the amount of compensation and expense exceed the amount of fees received, the excess is assessed upon and recovered from the electric-light companies. The board establishes rules and regulations, fixes standards, prescribes fees, and employs such means and methods for making examinations and tests of meters as in its judgment are most practicable, expedient, and economical. The fees charged for testing of various-sized meters in 1907–8 in New York, Massachusetts, and Canada are given in the accompanying table.

METER RATING.	RATES FOR TESTING WATT-HOUR METERS.			
	New York.	Massachusetts.	Canada.	
			Lamps.	Meters.
3 amperes	$1.00	$1.50	$0.75	$3.00
5 amperes	1.00	1.50	0.75	3.00
10 amperes	1.50	1.50	1.25	3.00
15 amperes	2.00	2.00	1.75	3.00
25 amperes	2.50	2.50	2.75	3.00
50 amperes	3.00	3.00	3.50	3.00
75 amperes	4.50	3.50	5.00	6.00
100 amperes	5.50	3.50	6.50	6.00
150 amperes	8.00	4.00	9.00	9.00
200 amperes	10.50	4.50	11.50	12.00
300 amperes	15.50	4.50	16.50	18.00
450 amperes	23.00	5.00	24.00	27.00
600 amperes	30.50	5.00	31.50	32.00
1,200 amperes	60.50	.....	61.50	72.00

It will not be out of place here to note that by the provisions of the Canadian law a meter must be tested and stamped every five years. The meters to be tested are brought to the government inspection office, or in small towns and villages the test is conducted on the premises of the electric-light company. When a customer wants his meter tested, he notifies the electric-light company and requests it to send a qualified person to detach the meter from the mains so that it may be taken to the inspector's office. The inspector files with either the electric-light company or the customer, on payment of the proper fee, a certificate stating the result of the inspection, with such particulars as he may deem right to insert for the information and guidance of the persons concerned. Electrolytic meters in use may be continued unless objected to by the purchaser, but all renewals of meters must be made by the substitution of direct-reading types. No meter is passed which, when working at its full rating, varies more than 3 per cent from the legal standard unit of electricity, in favor of either the electric-light company or the consumer. Whenever a reading of a meter is taken by the electric-light company, the company must give a duplicate of such reading to the consumer. In every case the owner must keep the meter in good repair and is responsible for the due inspection thereof.

Legislation in this general direction has been made effective in the control over meters given to such new "public-service commissions" as those in Wisconsin and New York, and steps have been taken by these commissions for the full examination of all meters and meter complaints. A report made public in 1909 by the New York commission of the first district of tests conducted in New York City showed a remarkably satisfactory state of affairs as to the general accuracy of meters in the district. Under the public-service laws of New York an electric meter is allowed a variation of 4 per cent either way, while a gas meter is allowed only 2 per cent.

The latest rules of the public-service commission for the city of New York relative to testing electric meters are embodied in printed forms. Forms are included for reports on complaint, periodic, and office tests of meters. The complaint test is defined as a test made by an electrical corporation, upon the premises where the meter is installed, as the result of a complaint of the customer. A periodic meter test is a test made by an electrical corporation in the regular course of its business, upon the premises where the meter is installed, but not at the time of installation, which test is not made as the result of a complaint from the consumer nor by special direction of the corporation or one of its officers or employees. An office meter test is a test made by an electrical corporation, upon the premises where the meter is installed, by special direction of the corporation itself or of an officer or employee.

The rules require that every electrical corporation operating within the first district shall file with the public-service commission a monthly report, in the form prescribed, stating the results of all tests of electric meters tested for accuracy during the month. Such reports must be made for each calendar month and be filed not later than the 15th day of the following month.

All tests are required to be made with the meter in its permanent position on the consumer's premises, and under actual operating conditions as regards voltage, frequency, temperature, stray fields, and vibration. Where shunts, series transformers, or shunt transformers are used in connection with a meter, the meter must be tested from the line side of such apparatus when the voltage does not exceed 600. In periodic tests, where the line voltage exceeds 600 volts, the meter may be tested as a self-contained meter,

Digitized by Google

and the ratio certificates of the transformers may be used in calculating the true line watts, provided the certificates are dated within the five years preceding the time the meter is tested. In compiaint and office tests the commission will accept the ratio certificates of the transformers, provided they are dated within the year preceding the time the meter is tested. When rotating standard meters are used the connections must be so arranged as to give the meter tester full control of the starting and stopping of the standard and at the same time allow him to count the revolutions of the meter under test.

Each meter must be tested independently, and no meter can be tested while connected in series with one or more other meters unless the potential circuit of each meter is so arranged as not to be fed through the field of any meter under test or rotating standard. All indicating and integrating instruments used as standard instruments in testing meters must be equipped with scales properly proportioned to the loads measured.

All meters must be adjusted so as to register with an error of not more than 1 per cent at light load and at full load, and both of these adjustments must be maintained in this condition as nearly as possible. All meters, whenever possible, are to be tested at three loads: One-tenth of the full rated capacity of the meter, normal load, and full rated capacity of the meter. The average of these tests obtained by multiplying the result of the test at normal load by three, adding the result of the tests at one-tenth capacity and full capacity, and dividing the total by five is deemed the condition of the meter, and such final average must be reported to the commission on the form prescribed by it. In an installation where it is impossible to obtain a load of 10 per cent of the rated capacity, or of 100 per cent of the rated capacity of the meter, tests are to be made at the nearest obtainable loads to 10 per cent and 100 per cent, respectively, of the rated capacity of the meter, and the values are to be given in the ratios.

The following classification, in percentage of installation, is used in determining normal test load:

A. Residence and apartment lighting	25 per cent
B. Elevator service	40 per cent
C. Factories (individual drive), churches, and offices.	45 per cent
D. Factories (shaft drive), theaters, clubs, entrances, hallways, and general store lighting	60 per cent
E. Saloons, restaurants, pumps, air compressors, ice machines, and moving-picture theaters	70 per cent
F. Sign and window lighting and blowers	100 per cent

When a meter is found to be connected to an installation consisting of two or more of the above classes of loads, the normal load used must be obtained by taking the average of the percentages for the classes so connected. Three tests are made at each load at which the meter is tested, but should any two fail to agree by 1 per cent, additional tests must be made until three results are obtained which do not vary one from another more than 1 per cent.

At Hartford, Conn., an interesting variation in meter practice has been worked out by the Hartford Electric Light Company, in connection with the introduction of the tungsten lamp in smaller sizes, designed for operation at 30 and 60 volts. Tests have shown that these low-voltage, extra high-efficiency lamps can be counted on for a life of at least two thousand hours. The filaments are tough and thick and will stand rough handling admirably. During the past two years several installations of these lamps have been made in residence service, and as a result the company is satisfied that it is advantageous to introduce them generally on its circuits. In order to handle the situation profitably, however, the company has worked out a plan of charging the customer for light used rather than billing on the usual basis of a price per kilowatt hour.

The plan consists in the substitution of a meter dial reading candlepower hours for the ordinary watt-hour dial of the ordinary induction meter and in charging the customer a rate of 0.025 cent per candlepower hour of service supplied. The customer pays the initial cost of installing the lamps, which is 20 cents apiece for either the 10, 20, or 30 candlepower, 30 or 60 volt lamps. Free renewals are given on all these lamps. The company installs an "economy coil," or compensator, in each residence to reduce the potential from that of the mains to 30 or 60 volts, as the case may be. This compensator has the advantage of absorbing the effect of voltage fluctuations on the high-tension lines back of the subway transformers from which secondary groups of loads are fed, and it is provided with multi-voltage taps for convenience. Mr. Dunham, president of the company, states:

> The whole system of meter measurement has gradually adjusted itself to a certain ratio between watts, or the power used in creating light, and the other costs entering into the production of the candlepower. This has been particularly the case with house lighting. The general average price of house lighting in the larger cities and in the older stations has become about 10 cents per kilowatt hour—that is, the whole cost of light is placed upon the kilowatt measurement, whereas more than one-half the cost consists of distribution management and "overhead" expenses. This is clearly shown by the fact that the same meter measurement of watts has an altogether different price when it is used simply as power. The price of power in the more modern stations and in the larger cities ranges from 2 to 6 cents per kilowatt hour, while the cost of light ranges from 4 to 12 cents, or about double the price of power, which would not be the fact if the customer paid for the same thing in both instances. For the power used the customer pays for the actual kilowatts, but for the light delivered the customer pays for the actual kilowatts used plus the various other expenses which have been attached by custom and necessity. This has placed all the stations in a peculiar relation to the old-fashioned watt-hour meters in regard to the new lamps, and they find themselves reduced in income, if they use the new lamps, to one-half of their old revenue. This can not be avoided except by changing the measuring instrument or by raising the price of the kilowatt hours used to double that charged for the old lamps, because the watt-hour meter measures a little less than half the actual cost of the candlepower.

Digitized by Google

Regulation and rates.—Various references have already been made in this chapter to the subjects of rates and regulation. It is well understood that in their dealings with the communities served, central-station companies have always been governed by the local-franchise ordinances under which they operated. But these franchises have dealt more with questions of public-street lighting than with such a feature as service to the private consumer; and it is in the latter respect that most change is noticeable of recent years. The change has been carried furthest in those states where public-service commissions exist, whose authority and control over public-utility corporations have been generously amplified by the respective legislative bodies delegating such powers. These states are notably Massachusetts, Wisconsin, and New York, but it is significant that, as a matter of record, in almost every instance where the commissions have been appealed to, the actions or methods of the corporations have been sustained; or if modified, the underlying principle has been adhered to as based on reason and equity.

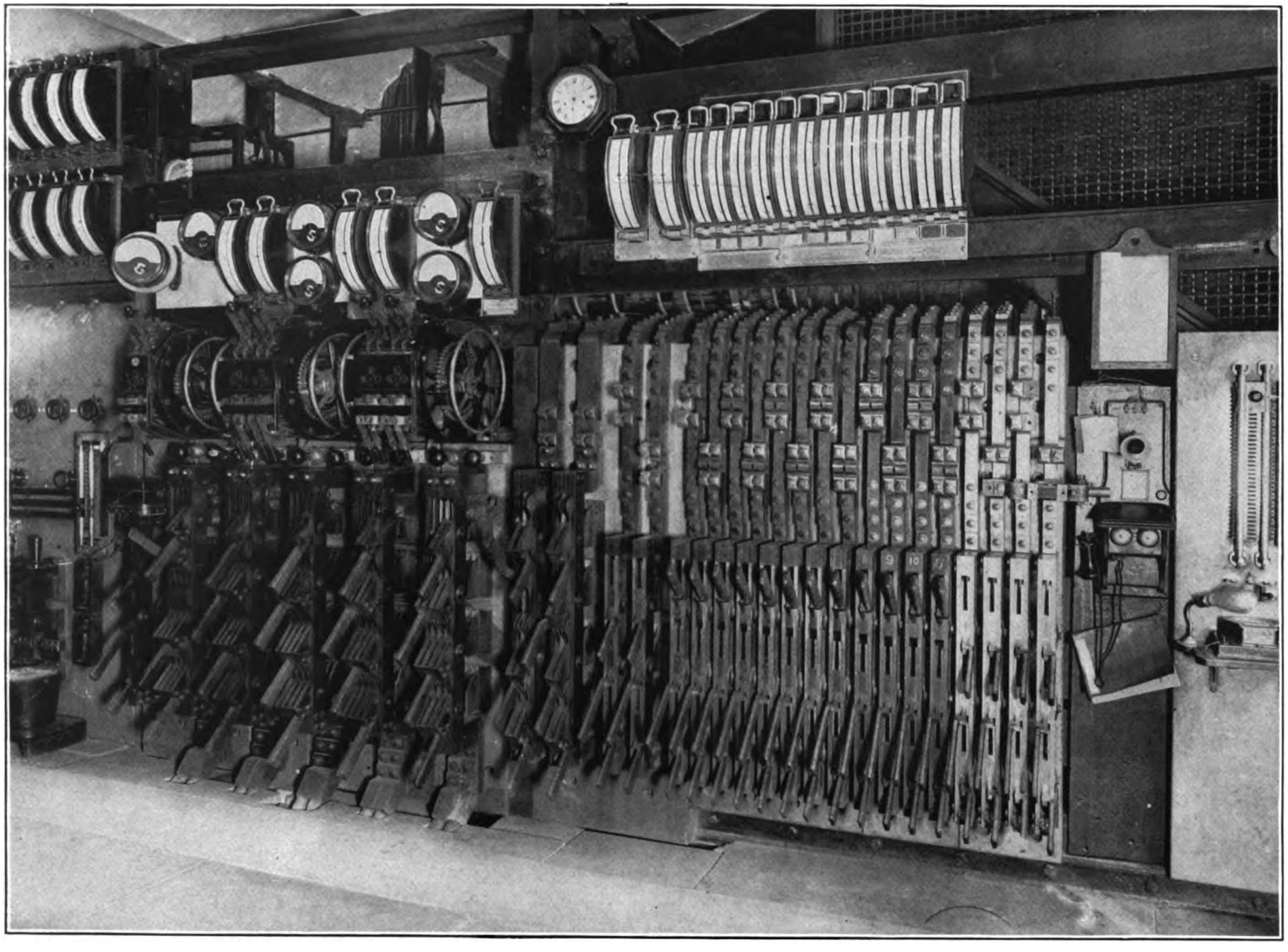
One of the most interesting recent cases is that in which the Wisconsin commission dealt with the application of the La Crosse Gas and Electric Company for the power to charge higher rates for electrical energy than had prevailed. The testimony and facts presented by the petitioner related mostly to the history of electric lighting in La Crosse, to the rates which the company was asking permission to establish, and to the various systems of fixed rates that were already in use. From the facts relating to the value of the plant and to its earnings and operating expenses, the commission said it was quite clear that the plant had not been a success as a producer of net earnings. This was especially true when some allowance was made for depreciation at 3 per cent. During the preceding two years the net earnings were not enough to pay any interest upon the investment nor even to meet ordinary depreciation charges, and so long as the rates charged for energy remained so low there was but little hope that the net earnings would increase. The decision included a discussion of one of the most important features of the problem—the cost to the company of serving each class of customers. It is not necessary to cite here the rates fixed, but the language of the decision is as follows:

> It further appears that the proposed rates are somewhat lower than those charged in other cities, both inside and outside of this state. The comparisons we have made upon this point are quite extensive. They embrace at least 20 cities in Wisconsin and fully as many in other states. These facts are of considerable importance, not only to the petitioner but the people who are served by this company. The petitioner has duties as well as rights in this matter. While it is entitled to reasonable rates for service it renders, it has not the right to exact more than this. It must also see to it that the services it renders are adequate and that they meet all reasonable requirements in this respect. It is as important that the interests of the public it serves should be as fully protected as those of its own. The best rates are those that are based upon the cost. Each customer should, under ordinary conditions, contribute his just proportion of all the expenses, as well as of the interest upon the investment. From the foregoing examination of the facts involved in this case it appears to us that the rates submitted by the petitioner fairly meet the situation, and that they are just and reasonable. It has been determined, therefore, that these rates shall be put into effect, subject, however, to such revision as may be found necessary when the plants in question have been appraised, or for other reasons.

At Minneapolis the city officials held that the rates of the Minneapolis General Electric Company were too high, and that the same rate per kilowatt hour, except for quantity discounts, should be made for all consumers without regard to conditions of load. The company had put in force a system of rates under which customers having the best load-factors—that is, those using current the largest number of hours per day—were given much the lowest rates. It appears from the reports of the early stages of the Minneapolis controversy that the city officials were chiefly concerned with lowering the maximum rates charged by the company for short-hour business. Several expert investigations were made into the company's affairs, with the result that the correctness of the company's theory of readiness-to-serve charges in connection with electric light and power business was upheld. The experts all agreed that the rates given to any individual customer should be dependent upon the fixed charges on the investment necessary to serve him, plus his share of the operating expenses necessary to serve customers in his class, rather than on the average expense of serving all classes of customers. However, as a concession to the smaller customers, it seems to have been generally agreed, both by the company and by the experts, that the maximum rates should be a little lower than those to which the smaller short-hour customers would be strictly and scientifically entitled. This reduction from the maximum rates to small short-hour customers was advocated only on the ground that the many small consumers, by the consent of whom the company had the use of the streets and public alleys for the distribution of its current, were entitled to receive compensation in this way for the franchise, and that larger consumers were not entitled to receive such compensation in the same proportion.

The Minneapolis General Electric Company and the committee of the city council came to an agreement on electric light and power rates as a groundwork for an ordinance giving the company a thirty-year franchise and fixing the rates for electric light and power for the first year of the franchise. The city council originally passed an ordinance requiring a uniform rate of 8 cents per kilowatt hour, with discounts purely according to quantity. The company refused to recognize this ordinance, on the ground that it was unjust, inequitable, and confiscatory. The point of interest in the controversy is that a company was able to convince a council committee and citizens of

Digitized by Google



SECTION OF SWITCHBOARD, NEW YORK EDISON SYSTEM.

Digitized by Google

Digitized by Google

the fairness of a rate based on load-factor, and of the unfairness of a uniform rate per kilowatt hour for all classes of business.

The residence-lighting rate which was agreed upon is 9 cents per kilowatt hour for the first fifty-two hours' use per month of 40 per cent of the connected load, and 6.66 cents for all over that. Commercial lighting is at the same rate, except that the maximum demand as measured by maximum-demand meters is substituted for 40 per cent of the connected load. Maximum bills are 100 per cent of the connected load. Minimum bills are $1 per month per lighting customer. Retail motor service pays 7.5 cents per kilowatt hour for the first fifty-two hours per month of the customer's maximum demand, and 2.5 cents for all over that. The minimum bill is $1 per month per horsepower connected. The chief differences between these rates and the old rates of the company are that the maximum rate has been reduced on lighting from 12.6 cents for fifty-two hours' use of 60 per cent of the connected lamps to 9 cents for 40 per cent, and the minimum bill on motors reduced from $2 to $1 per horsepower. Free incandescent-lamp renewals and free arc-lamp maintenance have been abolished under the new rates. Quantity discounts from 5 to 25 per cent are to be allowed on accounts of from $50 to $250 per month.

Professor Cooley, one of the experts employed in the investigations, pointed out that light and power furnished under a limited-term franchise ought to cost the consumer more than that furnished under a perpetual franchise, because the company must figure upon paying off its bondholders and stockholders completely at the end of the limited-franchise period. A company could certainly float 4 per cent bonds on a perpetual franchise where with a limited franchise it would pay 5 per cent.

Rates were changed in one or two of the leading cities during 1907. The ordinance fixing the maximum rates to be charged by the Commonwealth Edison Company of Chicago, until 1912 was passed by the Chicago city council on March 23 of the former year. This company pays 3 per cent of its gross receipts to the city, in accordance with the franchise previously owned by the Commonwealth Electric Company. The rates are as follows: Up to July 31, 1908, 15 cents per kilowatt hour as a primary rate for energy used up to the equivalent of thirty hours' use of the consumers' maximum demand, and 9 cents per kilowatt hour as a secondary rate for all energy in excess of the foregoing amount. From August 1, 1908, to July 31, 1909, the maximum rate is 13 cents and the secondary rate 9 cents. From August 1, 1909, to July 31, 1912, the primary rate is 13 cents and the secondary rate 7 cents. A discount of 1 cent per kilowatt hour from the foregoing rates is to be allowed on all bills paid within ten days.

The Union Electric Light and Power Company, of St. Louis, has put in force a new system of rates, which differs considerably from the typical systems in use. It is founded on the belief that the value of the service rendered to any individual should, so far as practicable, be based on the cost of serving him, and not on the average cost of serving the entire body of consumers; and that as the cost of supplying current per kilowatt hour varies greatly with the different classes of service, so the price per kilowatt hour, in justice to the several users, should vary greatly to different customers. The company felt compelled to recognize the force of the argument of the customer who maintained that he was entitled to a lower average rate if he guaranteed $5 per horsepower per month than his neighbor who would guarantee only $1 per horsepower per month. At first a system of "special" contracts was adopted to meet this condition; but complaints of unequal discriminations led later to the substitution of a graduated schedule of rates. Under it the service is divided into a very much larger number of classes than was ever before attempted, and every consumer in the same class gets the same rate.

Each customer's rate is based on the minimum monthly guarantee he is willing to make per horsepower or per 50-watt lamp connected, and the rate is inversely proportional to the amount of the connected load. For example, the customer having fewer than 100 lamps pays 12 cents per kilowatt hour if he guarantees only 10 cents per month per lamp. By guaranteeing 45 cents per month per lamp he gets a rate of 10 cents per kilowatt hour, and by guaranteeing 65 cents per month per lamp, a rate of only 8 cents per kilowatt hour. Of the customers furnishing the 10-cent guarantee there are 15 subclasses, each with its own modified rate. The rate also declines as the number of connected lamps increases. For example, a customer guaranteeing 10 cents per month per lamp and having less than 100 lamps pays 12 cents per kilowatt hour. This rate is reduced by gradations until for 3,000 lamps or over, with a 10-cent-per-lamp guarantee, the rate is 6 cents per kilowatt hour. For the 45-cent-per-lamp guarantee the customer with fewer than 100 lamps pays 10 cents per kilowatt hour, while the customer with 3,000 lamps pays 5.2 cents per kilowatt hour.

All these rates are subject to discounts based on hours' use and quantity. The discount made according to the equivalent daily hours' use of the entire connected load starts with a 6 per cent discount for a kilowatt-hour consumption equivalent to one hour's use per day of the connected load, and rises by gradations to 25 per cent discount for a kilowatt-hour consumption equivalent to eighteen hours per day of the connected load. There is, also, in addition to this, a discount based on the amount of the bill, which is from 5 per cent on bills of under $10 to 56 per cent on bills of over $9,000 per month.

Digitized by Google

The motor rates are graded on the same plan. For a 1-horsepower motor customer they vary from 10 cents per kilowatt hour on a guarantee of $1 per month per horsepower to 5 cents per kilowatt hour on a guarantee of $7.50 per month per horsepower. The rate also depends on horsepower connected. Under the guarantee of $1 per month per horsepower the customer with over 500 horsepower gets a 5.5-cent rate. Under a guarantee of $2 per month per horsepower the rate is 4.5 cents. The rates for heating and cooking circuits in residences are 12 cents per kilowatt hour on a minimum monthly guarantee of $2, 11 cents on a $3 guarantee, 10 cents on a $4 guarantee, 9 cents on a $5 guarantee, 8 cents on a $7.50 guarantee, 7.5 cents on a $10 guarantee, and 7 cents on a $15 guarantee. On these cooking rates a discount is given according to the quantity of current consumed; on bills of $5 or under 5 per cent is deducted, and this per cent increases by 1 for each $1 of increase in the bills up to $15, at which point the discount is 15 per cent. For bills of over $25 the discount is 20 per cent.

In its annual report[1] for 1908 the Wisconsin commission said that it found the rates filed by the larger companies to be generally based on scientific considerations, but that those of the smaller companies partook of "every conceivable form and method of determination." Out of 119 companies reporting, 50 had no discriminatory rates, and 3 out of every 100 customers paid less than the schedule rates. The report went on to say: "Because a certain utility has more discriminations in effect than another does not mean in itself that it is following a vicious practice or is using unlawful methods. Most of the discriminations cited are remnants of a former period of unrestricted competition; others are the outgrowth of circumstances over which the utilities themselves have no control." In a recent address President Meyer of the commission said that the "sliding-scale arrangement is full of promise for the future," because "when the individual manager feels that with greater and keener application, with increased efficiency and economy, the rate of return on his investment will be increased, he is much more likely to aim toward efficiency and economy than he would if no such inducements were held out to him."

Both the Wisconsin and the New York commissions have sought to introduce a uniform classification of accounts for electric companies. Two sets of accounts are required in Wisconsin. In general, electric plants operating in cities of 10,000 inhabitants or over must keep at least the list of accounts prescribed in Class A, and all plants in cities of under 10,000 population must keep the accounts prescribed in Class B. Any changes or additions proposed by a company must be filed with the commission before the accounts in question are opened. At a meeting of the Northwestern Electrical Association the classification was spoken of in terms of approval by Mr. C. M. Duffy, comptroller of the Milwaukee Electric Railway and Light Company and chairman of the accounting committee of the association, who said that he did not understand how anyone engaged in the electric-lighting business would be willing to conduct it and know less about its finances than would be required by the commission. The fundamental principle of the accounting system is that all the costs of generating current shall be kept distinct from the other expenses. In New York state, also, both the commissions have put into force rules and systems for uniform accounting.

In New York City one of the features of the rate work of the public-service commission of the first district has been to make a more general provision for "breakdown" service. It has placed the price of this service at $30 per kilowatt of maximum demand, against which the real consumption is an offset at regular rates. In other words, the commission has recognized the inherent propriety of a stand-by readiness-to-serve charge. The commission of the first district made an exhaustive investigation of the contracts made by the companies, revealing a negligible number of special contracts—one or two hundred in scores of thousands—and many of these, as in other businesses, left over from a former management or other control. One of the acts of the commission has been to prohibit specifically any "undue or unreasonable preference" or advantage "to anybody, while no charge shall be made that is not in a filed schedule, nor shall any electrical corporation refund or remit in any manner or by any device any portion of the rates or charges so specified." It is obvious that the immediate effect of such a general policy is to compel companies to classify their customers more closely, so that all in any given group shall be treated alike. The fundamental fact is that very few cases are alike in all particulars. Even where like conditions exist, sometimes the parties in question can not be persuaded of it, and the companies have insisted on the impossibility of meeting the rules of the commission either as to publishing every little concession to a customer's wishes or as to strict conformity with all the terms prescribed for contracts. A brief on this point filed with the commission by the New York Edison Company pointed out that one of its most important forms of contracts was for supplying energy to large buildings by wholesale or in bulk. These contracts were largely the result of personal canvass and individual negotiation, and it was claimed that if the company was not permitted to modify the phrasing or minor details of such contracts to suit peculiar conditions its business would be seriously interfered with. The company stated that it did not seek to make special terms or give unusual privileges to particular customers, but simply to be permitted to

[1] Second Annual Report of the Railroad Commission of Wisconsin, 1908.

Digitized by Google

modify the contracts to suit different conditions. It desired only to extend to every customer any convenience or facility that the special conditions surrounding the service made practicable, provided that the peculiar features introduced into the contract did not modify the cost to the consumer, and provided that the company was prepared to extend the same privileges to all others who presented the same conditions. The company expressed itself as quite willing to accept and obey the order of the commission in so far as it prohibited any variation in charge, preference in rates, refunds, or special privileges, but it believed that special riders to the contracts with customers should be permitted to meet special conditions that did not affect the actual cost of furnishing the current, and it did not mean to discriminate in any way in favor of one customer as against another.

A valuable study of the whole subject of rates for electric energy is found in the decision of the Board of Gas and Electric Light Commissioners of Massachusetts in the matter of the complaint of the Public Franchise League against the Edison Electric Illuminating Company of Boston, filed May 29, 1908. In the opinion many of the points already discussed in this report, and others raised in the controversy, are given careful consideration. The Edison Electric Illuminating Company of Boston, like many other companies, has had a system of rates based upon "fixed costs" and "running costs," so as to charge each customer substantially the cost to it of supplying him, inclusive of a reasonable return on the investment—the basic method being known as the "maximum-demand" system. One of the various modifications of this system in use in America is the Doherty system, in operation in Denver and other cities. It is based fundamentally on the readiness-to-serve principle and aims at a more or less exact adjustment of the price to the consumer to the cost of producing that for which he contracts, and diverges widely from the idea of a uniform rate for all customers.

Digitized by Google

Digitized by Google

GENERAL TABLES

Digitized by Google

TABLE 117.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—

	STATE OR TERRITORY.	Census.	Number of stations.	Cost of construction and equipment.	INCOME.					EXPENSES.	
					Gross income.	Electric service.				All other sources.	Total.	Salaries and wages.
						Total.	Lighting.	Stationary motors.	All other.			
1	United States	1907	4,714	$1,096,913,622	$175,642,338	$169,614,691	$125,755,114	$28,511,550	$15,348,027	$6,027,647	$106,205,149	$35,420,324
2		1902	3,620	504,740,352	85,700,605	[2]84,186,605	70,138,147	9,910,217	4,138,241	1,514,000	55,457,830	20,646,692
3	Alabama	1907	55	7,293,876	1,012,743	997,506	827,094	84,805	85,607	15,237	650,231	208,533
4		1902	25	908,895	385,263	374,138	330,756	30,175	13,207	11,125	243,059	87,049
5	Arizona	1907	15	1,672,589	569,850	544,192	446,962	71,808	25,422	25,658	414,347	130,683
6		1902	13	810,341	293,066	288,019	243,239	44,780	.....	5,047	222,053	82,644
7	Arkansas	1907	63	1,922,658	675,718	664,916	620,306	18,248	26,362	10,802	443,735	157,814
8		1902	42	1,082,505	425,317	413,775	383,113	23,214	7,448	11,542	256,177	90,759
9	California	1907	129	111,780,551	14,416,529	13,922,028	8,111,012	3,826,462	1,984,554	494,501	8,357,184	3,094,193
10		1902	115	36,547,474	5,066,417	4,946,090	3,305,318	1,228,099	412,673	120,327	3,219,422	1,176,741
11	Colorado	1907	56	23,126,179	3,410,240	3,317,844	2,181,310	951,836	184,698	92,396	2,150,135	775,045
12		1902	48	8,665,826	1,652,505	1,628,953	1,209,760	343,559	75,634	23,552	1,282,246	482,588
13	Connecticut	1907	41	13,416,011	2,469,543	2,452,359	1,872,933	407,577	171,849	17,184	1,422,717	529,652
14		1902	38	6,583,477	1,319,549	1,317,512	1,113,754	155,732	48,026	2,037	840,735	329,763
15	Delaware[1]	1907	14	12,735,909	1,464,644	1,442,388	1,185,043	191,609	65,736	22,256	874,901	262,698
16		1902	10	4,667,770	749,841	742,080	562,729	79,133	100,218	7,761	570,772	121,711
17	Florida	1907	37	1,630,061	654,251	630,632	607,492	16,220	6,920	23,619	433,230	156,700
18		1902	26	974,425	324,770	323,414	308,476	7,378	7,560	1,356	207,807	73,315
19	Georgia	1907	93	7,354,286	1,110,510	1,086,601	731,852	132,964	221,785	23,909	612,975	232,711
20		1902	43	1,252,578	357,565	348,753	311,603	35,350	1,800	8,812	235,038	92,173
21	Idaho	1907	42	3,251,460	719,395	692,489	546,309	100,291	45,889	26,906	415,579	171,125
22		1902	19	785,030	192,206	191,126	185,535	5,591	.....	1,080	127,510	66,719
23	Illinois	1907	383	88,142,233	15,465,993	14,566,772	10,278,668	2,445,280	1,842,824	899,221	8,252,762	3,032,721
24		1902	346	38,329,275	6,757,015	6,692,248	5,849,351	763,764	79,133	64,767	4,204,046	1,603,904
25	Indiana	1907	200	25,680,710	4,438,332	4,222,610	3,457,753	568,199	196,658	215,722	2,895,729	969,263
26		1902	180	6,706,510	2,105,146	2,038,121	1,916,135	120,435	1,551	67,025	1,442,115	549,428
27	Iowa	1907	192	9,986,666	2,479,969	2,317,880	2,015,394	261,202	41,284	162,089	1,701,173	547,177
28		1902	169	8,554,234	1,545,663	1,477,348	1,399,644	78,180	9,524	68,315	1,091,943	406,819
29	Kansas	1907	111	6,589,805	1,514,867	1,419,091	1,092,153	224,224	102,714	95,776	1,031,312	374,496
30		1902	61	2,023,886	650,833	611,966	563,403	48,558	5	38,867	455,235	167,762
31	Kentucky	1907	83	10,356,088	1,660,700	1,610,475	1,371,567	220,061	18,847	50,225	1,010,338	301,794
32		1902	58	3,670,152	850,086	848,399	740,878	92,401	15,120	1,687	636,854	216,438
33	Louisiana	1907	42	11,614,121	1,852,383	1,829,128	1,573,879	228,680	26,569	23,255	1,189,726	382,982
34		1902	25	6,056,603	971,631	967,027	850,471	116,556	.....	4,604	532,776	226,050
35	Maine	1907	81	12,629,101	1,453,016	1,324,648	970,243	284,627	69,778	128,368	866,807	308,006
36		1902	52	4,824,850	692,350	668,575	574,718	92,032	1,825	23,775	479,850	202,726
37	Maryland	1907	36	21,274,959	1,883,084	1,856,359	1,498,286	349,059	9,014	26,725	1,517,770	496,810
38		1902	32	7,157,986	962,207	951,316	854,798	91,437	5,081	10,891	604,376	204,888
39	Massachusetts	1907	120	43,279,226	10,749,240	10,602,498	8,543,327	1,519,708	539,463	146,742	6,809,793	2,235,647
40		1902	114	29,562,267	6,340,944	6,244,882	5,263,113	744,879	236,890	96,062	4,428,981	1,588,836
41	Michigan	1907	234	37,001,060	6,072,010	5,750,447	3,848,797	873,081	1,028,569	321,563	3,754,215	1,126,813
42		1902	201	11,559,169	2,613,812	2,516,800	2,285,995	173,881	56,924	97,012	1,743,218	728,952
43	Minnesota	1907	171	24,138,081	3,478,009	3,333,469	2,700,959	536,622	95,888	144,540	2,259,919	755,778
44		1902	138	9,296,505	1,858,789	1,838,806	1,615,766	191,432	31,608	19,983	1,230,928	433,256
45	Mississippi	1907	68	2,220,662	686,700	667,543	621,959	26,133	19,451	19,157	441,281	161,433
46		1902	43	899,477	366,934	341,546	319,393	18,741	3,412	25,388	263,459	95,300
47	Missouri	1907	162	33,865,760	5,805,828	5,683,795	4,116,409	985,596	581,790	122,033	3,754,747	1,306,640
48		1902	123	15,679,872	2,392,149	2,360,150	1,954,562	402,937	2,651	31,999	1,695,316	684,197
49	Montana	1907	33	17,950,677	2,469,131	2,376,472	1,150,342	963,669	262,461	92,659	1,102,955	360,768
50		1902	27	4,740,807	1,025,971	1,017,805	697,488	32,881	287,436	8,166	547,686	218,302
51	Nebraska	1907	98	7,372,081	1,562,669	1,474,426	1,232,411	168,402	73,613	88,243	968,713	313,427
52		1902	54	3,305,840	601,777	597,304	542,317	54,812	175	4,473	376,418	149,190
53	Nevada	1907	9	4,299,631	372,108	352,959	194,525	148,560	9,874	19,149	198,491	77,264
54		1902	5	301,785	44,549	44,549	44,399	150	.....	.....	31,887	14,776
55	New Hampshire	1907	56	8,695,652	1,422,345	1,321,296	825,315	190,764	305,217	101,049	704,964	286,749
56		1902	51	6,447,560	832,322	826,176	609,385	82,257	134,534	6,146	436,027	187,933
57	New Jersey	1907	64	65,219,445	5,952,378	5,910,745	5,123,926	682,028	104,791	41,633	3,702,064	1,370,506
58		1902	64	56,432,502	3,421,304	3,356,599	2,799,961	258,055	298,583	64,705	2,209,227	821,739
59	New Mexico	1907	15	989,317	292,682	289,962	228,151	24,033	37,778	2,720	208,614	66,981
60		1902	11	369,877	135,307	133,747	127,747	6,000	.....	1,560	95,471	34,740
61	New York	1907	314	252,731,789	34,859,170	34,067,383	24,296,438	5,688,401	4,082,544	791,787	19,528,187	5,819,617
62		1902	256	112,998,778	16,854,839	16,742,239	12,920,807	2,396,046	1,425,386	112,600	10,494,276	3,904,706

[1] Exclusive of 7,082 arc and 267,997 incandescent lamps used by the establishments reporting to light their own electric properties.
[2] Includes estimated income of municipal stations from public lighting.

Digitized by Google

COMPARATIVE SUMMARY, BY STATES AND TERRITORIES: 1907 AND 1902.

EXPENSES—continued.			Horsepower of engines and water wheels (including auxiliary engines).	Kilowatt capacity of dynamos.	Output of stations, kilowatt hours.	NUMBER OF LAMPS.[1]			EMPLOYEES.				
Cost of supplies and materials.	Cost of fuel.	Rents, taxes, insurance, and other miscellaneous expenses.				Arc.	Incandescent.	All other (including Nernst, vacuum, vapor, etc.).	Salaried officials and clerks.		Wage-earners.		
									Number.	Salaries.	Average number.	Wages.	
$21,400,823	$23,057,745	$26,326,257	4,098,188	2,709,225	5,862,276,737	555,713	41,445,997	162,338	12,990	$11,733,787	34,642	$23,686,537	1
11,280,423	11,635,509	11,895,206	1,845,048	1,212,235	2,507,051,115	385,698	18,194,044	.....	6,996	5,663,580	23,330	14,983,112	2
87,032	216,013	138,653	26,404	17,124	30,846,764	4,926	232,577	69	109	82,498	234	126,035	3
50,731	62,243	43,036	7,620	4,473	11,616,707	2,033	61,373	.....	41	31,637	121	55,412	4
52,989	178,232	52,463	7,746	4,939	9,392,302	754	72,001	27	58	55,596	90	75,067	5
30,324	86,465	22,620	2,540	1,811	3,662,045	295	36,556	.....	28	30,545	58	52,099	6
58,799	169,967	57,155	13,953	9,678	11,519,316	1,669	142,446	79	75	52,670	169	105,144	7
63,592	66,294	35,532	8,433	6,024	9,965,997	1,654	82,234	.....	36	27,354	113	63,405	8
1,940,030	1,122,639	2,200,322	384,673	238,480	661,606,309	19,691	3,067,383	831	927	1,141,902	2,201	1,952,291	9
803,390	562,742	676,549	134,788	83,816	152,728,042	15,764	1,006,875	.....	351	395,587	1,009	781,154	10
333,516	486,033	552,541	82,427	53,130	123,275,212	5,391	648,446	1,048	220	220,340	698	554,705	11
280,822	227,201	291,635	38,268	21,808	60,177,084	4,770	295,605	.....	155	141,885	433	340,703	12
247,029	334,733	311,303	56,243	39,363	67,406,232	7,639	576,661	10,226	170	166,759	575	362,893	13
209,125	178,099	123,768	28,389	15,516	26,738,121	6,399	271,805	.....	104	106,807	395	222,956	14
196,534	155,299	260,370	33,805	26,733	30,543,522	4,473	412,948	3,282	96	84,244	258	178,454	15
165,897	116,079	167,085	10,123	8,432	17,871,872	3,144	157,671	.....	45	34,729	163	86,982	16
54,036	187,324	35,170	14,370	7,804	11,765,994	1,408	141,258	26	71	47,064	194	109,636	17
24,983	92,393	17,116	6,114	4,699	8,066,078	1,106	61,144	.....	30	18,044	106	55,271	18
106,757	166,641	106,866	54,704	35,446	59,311,202	3,173	179,913	424	132	102,862	252	129,849	19
62,073	58,863	21,929	12,630	7,620	9,911,243	1,452	60,139	.....	56	32,467	147	59,706	20
137,625	39,461	67,368	13,694	7,082	9,577,588	966	122,460	31	72	82,755	116	88,370	21
22,745	14,906	23,140	5,454	2,774	5,018,149	557	33,262	.....	23	19,790	65	46,929	22
1,376,655	2,006,053	1,837,333	299,246	209,226	467,657,328	55,309	3,582,178	9,131	1,034	982,854	2,868	2,049,867	23
742,277	989,076	868,789	126,866	100,320	161,543,646	38,215	1,567,665	.....	580	480,947	1,759	1,122,957	24
509,059	863,435	553,972	116,828	81,576	130,263,693	22,165	1,325,182	5,478	448	310,136	1,170	659,127	25
318,804	353,346	220,537	54,237	38,144	75,585,493	15,325	656,451	.....	243	156,360	698	393,068	26
367,081	533,438	253,477	46,739	32,056	37,729,072	7,352	808,451	935	278	188,899	577	358,278	27
175,236	349,399	160,489	39,504	24,886	36,506,425	5,929	420,847	.....	196	117,589	536	289,230	28
175,798	301,410	179,608	48,374	30,307	59,740,179	5,685	471,876	875	182	136,160	385	238,336	29
131,330	78,723	77,420	13,283	8,596	13,326,518	3,498	128,857	.....	78	44,606	214	123,156	30
201,944	298,270	208,330	41,984	29,140	37,232,623	6,884	483,401	395	124	100,691	461	201,103	31
90,985	146,296	183,135	21,415	15,012	27,835,614	4,598	142,662	.....	75	60,563	292	155,875	32
196,193	289,579	320,972	23,292	15,175	26,421,316	8,587	376,990	235	113	97,053	428	285,929	33
102,356	115,762	88,608	13,767	7,781	17,474,261	4,278	135,593	.....	78	67,099	258	158,951	34
220,159	116,689	221,953	57,880	39,290	66,136,651	3,187	442,940	252	157	98,761	345	209,245	35
96,595	77,932	102,597	24,889	15,291	21,987,700	2,254	204,632	.....	88	50,396	252	152,330	36
222,156	325,158	473,646	51,541	36,223	47,868,675	9,292	634,705	4,844	160	157,825	510	338,985	37
106,422	176,101	116,965	19,740	13,207	22,128,125	5,761	125,087	.....	83	53,444	258	151,444	38
1,438,911	1,376,830	1,758,405	188,335	135,924	219,425,607	33,869	2,650,724	4,579	655	689,496	2,017	1,546,151	39
621,057	909,420	1,309,668	124,213	90,624	125,813,392	28,790	1,420,963	.....	459	471,250	1,565	1,117,586	40
1,090,659	852,734	684,009	184,207	101,714	208,154,199	23,514	1,711,689	5,650	554	381,337	1,226	745,476	41
346,616	407,568	260,082	64,883	44,176	80,564,630	17,712	805,127	.....	313	203,694	942	525,258	42
580,410	540,935	382,796	121,825	78,516	87,579,431	13,398	900,119	2,904	292	261,578	770	494,200	43
251,484	337,201	208,987	34,823	20,999	40,258,632	8,543	384,705	.....	175	123,653	474	309,603	44
47,173	167,733	64,942	15,522	9,884	15,704,624	1,694	141,027	52	103	71,213	185	90,220	45
56,528	81,226	30,405	7,660	5,106	9,825,926	1,035	85,111	.....	44	29,422	138	65,878	46
717,251	767,710	963,146	111,416	68,467	147,328,446	17,576	1,698,935	6,461	482	447,578	1,318	859,062	47
305,558	427,166	278,395	45,318	32,100	57,450,731	13,144	593,798	.....	219	185,715	778	498,482	48
300,818	122,551	318,818	68,817	39,602	137,379,261	3,132	230,837	364	122	175,087	197	185,681	49
110,459	95,241	123,684	31,887	22,055	36,435,766	1,648	101,868	.....	53	73,308	149	144,994	50
168,144	307,992	179,150	30,020	20,041	31,958,739	4,262	488,932	1,169	119	104,250	285	209,177	51
78,331	82,598	66,299	12,308	8,412	12,315,775	2,608	151,162	.....	55	42,801	182	106,389	52
50,600	15,867	54,760	6,980	5,690	29,621,730	327	63,904	35	23	27,071	55	50,193	53
11,460	2,260	3,391	1,720	764	1,508,910	78	8,213	.....	7	5,400	11	9,376	54
112,927	142,251	163,037	46,784	31,917	55,258,921	3,510	301,300	434	109	83,568	313	203,181	55
71,341	80,627	96,126	28,096	17,777	27,377,793	2,879	170,541	.....	77	46,580	217	141,353	56
691,810	1,002,471	637,277	93,602	70,566	140,527,522	21,973	1,673,082	1,939	399	419,954	1,360	950,552	57
449,766	504,076	433,646	68,761	46,120	78,739,456	15,685	646,762	.....	258	265,566	816	556,173	58
48,399	52,798	40,436	4,548	3,783	4,614,349	332	55,229	150	27	21,505	56	45,476	59
22,363	24,359	14,009	1,780	986	2,637,810	272	22,507	.....	12	11,320	33	23,420	60
4,028,067	3,002,261	6,678,242	722,653	482,031	1,452,222,471	97,529	6,991,406	25,655	1,879	1,775,526	5,837	4,044,091	61
2,433,526	1,494,043	2,662,001	323,413	187,252	701,769,716	59,130	3,705,525	.....	897	814,600	4,524	3,090,106	62

[1] Includes 2 stations in 1902 and 1 in 1907 in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 117.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—

	STATE OR TERRITORY.	Census.	Number of stations.	Cost of construction and equipment.	INCOME.						EXPENSES.	
					Gross income.	Electric service.				All other sources.	Total.	Salaries and wages.
						Total.	Lighting.	Stationary motors.	All other.			
63	North Carolina	1907	71	$2,241,791	$543,322	$527,672	$425,856	$76,431	$25,385	$15,650	$370,375	$131,013
64		1902	38	803,936	250,133	241,903	226,376	15,527	.....	8,230	163,639	67,996
65	North Dakota	1907	29	1,619,997	533,383	480,042	421,711	40,794	17,537	53,341	368,604	113,383
66		1902	21	416,843	197,689	197,375	182,525	8,850	6,000	314	152,005	47,260
67	Ohio	1907	272	42,557,000	7,643,997	7,474,980	6,282,861	1,054,076	138,043	169,017	5,336,848	1,543,925
68		1902	233	26,381,397	4,431,038	4,347,506	3,873,339	407,901	66,266	83,532	2,944,706	1,053,991
69	Oklahoma	1907	72	7,130,864	1,106,316	1,097,134	920,737	103,920	72,477	9,182	791,687	264,604
70		1902[2]	20	597,516	281,452	267,453	254,627	12,826	.....	13,999	166,039	61,929
71	Oregon	1907	61	14,403,278	1,965,245	1,840,155	1,280,949	375,306	183,900	125,090	918,760	416,424
72		1902	39	5,157,651	691,582	638,571	497,629	89,942	51,000	53,011	338,142	167,755
73	Pennsylvania	1907	327	73,907,749	16,015,392	15,400,800	12,081,602	2,101,320	1,217,878	614,592	9,884,187	3,241,421
74		1902	279	41,579,338	9,486,867	9,311,416	8,321,766	640,948	348,702	175,451	5,779,371	2,095,415
75	Rhode Island	1907	7	7,327,862	1,724,659	1,627,190	1,257,521	302,513	67,156	97,469	990,845	350,605
76		1902	7	5,428,796	1,026,407	985,595	816,773	120,935	47,887	40,812	763,414	238,724
77	South Carolina	1907	40	8,803,382	901,537	865,708	409,665	432,384	23,659	35,829	511,486	145,357
78		1902	24	2,442,989	387,010	356,066	180,973	169,353	5,740	30,944	213,439	75,642
79	South Dakota	1907	37	2,806,363	513,682	492,767	379,963	110,651	2,153	20,915	359,086	127,143
80		1902	28	623,504	207,868	204,292	199,254	5,038	.....	3,576	151,471	58,116
81	Tennessee	1907	78	7,514,333	1,299,963	1,266,610	1,063,323	130,798	72,489	33,373	736,964	247,764
82		1902	54	3,603,088	912,482	911,555	716,417	134,023	61,115	927	480,171	165,041
83	Texas	1907	218	11,313,529	3,792,203	3,668,722	3,066,994	376,897	224,831	123,481	2,900,888	789,219
84		1902	137	5,510,491	2,074,558	2,049,225	1,753,681	203,859	91,685	25,333	1,435,016	509,181
85	Utah	1907	31	5,148,596	665,241	627,332	249,472	173,439	204,421	37,909	353,108	159,686
86		1902	16	7,521,780	714,353	664,240	435,426	156,331	72,483	50,113	452,814	177,391
87	Vermont	1907	60	7,234,498	841,701	795,391	603,381	162,376	29,634	46,310	521,143	188,780
88		1902	52	2,691,170	485,505	461,898	372,408	67,771	21,719	23,607	293,965	132,645
89	Virginia	1907	51	1,790,271	390,628	380,779	319,902	40,746	20,131	9,849	238,205	99,060
90		1902	37	1,039,347	210,632	210,176	202,135	8,041	.....	456	160,440	68,249
91	Washington	1907	71	20,789,849	3,410,542	3,219,814	2,078,156	531,818	609,840	190,728	1,911,691	800,441
92		1902	40	3,537,022	783,651	739,743	586,274	66,866	86,603	43,908	566,667	218,177
93	West Virginia	1907	48	2,682,935	724,253	689,919	567,027	43,084	79,808	34,334	479,011	166,633
94		1902	41	1,123,449	322,015	320,443	307,166	7,509	5,768	1,572	225,860	95,343
95	Wisconsin	1907	206	10,478,355	2,278,637	2,127,080	1,783,357	253,087	90,636	151,557	1,641,894	541,049
96		1902	152	4,678,316	1,288,020	1,270,669	1,178,349	75,992	16,328	17,351	861,194	324,308
97	Wyoming	1907	18	942,326	317,580	303,683	291,822	11,761	100	13,897	215,773	77,811
98		1902	13	467,463	159,216	159,016	158,415	60	541	200	104,549	46,125
99	Alaska	1907	9	626,837	416,103	397,332	287,347	109,985	.....	18,771	322,810	131,371
100		1902[3]	4	822,523	336,005	207,600	183,595	24,005	.....	128,405	261,984	89,154
101	Hawaii and Porto Rico	1907[4]	6	632,936	321,592	307,774	269,455	32,295	6,024	13,818	208,401	85,509
102		1902[5]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1] Exclusive of 7,082 arc and 267,997 incandescent lamps used by the establishments reporting to light their own electric properties.
[2] Includes Indian Territory in 1902.
[3] Includes 2 stations in Hawaii, in order that the operations of individual stations may not be disclosed.

Digitized by Google

COMPARATIVE SUMMARY, BY STATES AND TERRITORIES: 1907 AND 1902—Continued.

EXPENSES—continued.			Horsepower of engines and water wheels (including auxiliary engines).	Kilowatt capacity of dynamos.	Output of stations, kilowatt hours.	NUMBER OF LAMPS.[1]			EMPLOYEES.				
Cost of supplies and materials.	Cost of fuel.	Rents, taxes, insurance, and other miscellaneous expenses.				Arc.	Incandescent.	All other (including Nernst, vacuum, vapor, etc.).	Salaried officials and clerks.		Wage-earners.		
									Number.	Salaries.	Average number.	Wages.	
$62,948	$134,064	$42,350	20,683	13,911	13,171,681	1,936	144,159	97	72	$50,937	176	$80,076	63
36,330	43,275	16,038	6,566	4,141	8,351,346	1,178	45,181	.....	45	27,934	96	40,062	64
33,186	182,404	39,631	10,277	5,819	8,239,765	1,163	118,875	358	49	43,205	101	70,178	65
18,567	66,505	19,673	3,930	2,042	5,850,115	502	41,916	.....	25	16,470	50	30,790	66
869,760	1,307,873	1,615,290	179,111	126,533	217,311,924	43,849	2,254,467	13,491	660	517,401	1,497	1,026,524	67
564,844	704,104	621,767	103,745	69,811	127,437,383	31,839	934,213	.....	465	263,190	1,301	790,801	68
71,885	288,253	166,945	22,623	15,499	24,985,903	3,451	218,884	653	126	92,329	288	172,275	69
23,559	63,958	16,593	4,407	3,019	3,825,763	914	37,443	.....	21	19,280	71	42,649	70
130,883	173,588	197,865	126,815	32,587	92,807,992	3,927	370,092	2,752	118	130,792	349	285,632	71
36,176	63,158	71,053	17,798	11,165	17,531,660	2,023	95,045	.....	46	61,340	141	106,415	72
2,334,458	1,975,553	2,332,755	302,537	212,543	416,554,167	66,777	3,861,171	36,491	1,189	1,054,939	3,313	2,186,482	73
1,092,274	1,261,144	1,330,538	175,510	121,388	241,094,328	47,722	1,783,683	.....	713	535,721	2,467	1,559,694	74
165,642	245,386	229,212	27,986	21,040	35,651,323	5,970	384,597	732	73	102,077	377	248,528	75
160,311	145,607	218,772	17,600	12,139	23,436,435	5,161	196,188	.....	38	71,494	236	167,230	76
94,301	104,043	167,785	84,115	51,271	68,696,424	2,521	149,907	111	93	67,958	168	77,399	77
65,530	44,922	27,345	21,205	13,390	18,426,763	1,366	46,068	.....	40	26,479	120	49,163	78
58,844	140,739	32,360	12,984	10,046	13,615,015	1,278	129,486	157	56	55,710	113	71,433	79
37,645	37,611	18,099	5,057	2,910	4,256,007	798	63,248	.....	22	18,068	63	40,048	80
108,251	225,985	154,964	28,730	20,911	34,847,956	4,407	306,818	85	121	93,558	295	154,206	81
99,097	123,655	92,378	19,003	14,736	24,472,632	3,662	174,291	.....	65	48,967	241	116,054	82
361,135	1,178,812	571,722	71,914	48,558	75,829,108	8,176	794,972	9,351	378	278,797	897	510,422	83
325,305	337,730	262,800	34,887	26,108	48,888,450	5,146	303,591	.....	173	127,747	600	381,434	84
113,974	7,616	71,832	35,950	33,592	61,672,661	440	67,663	7	61	55,356	137	104,330	85
103,839	52,883	118,701	20,460	13,923	32,457,063	1,469	92,165	.....	69	57,543	171	119,848	86
118,071	59,895	154,397	38,566	21,854	29,923,333	1,866	305,593	652	109	69,006	188	119,774	87
65,221	42,251	53,848	23,857	11,442	22,374,060	1,534	161,106	.....	89	39,595	153	93,050	88
54,188	51,370	33,587	14,619	9,195	10,208,360	1,415	93,035	000	66	38,207	112	60,853	89
30,947	38,329	22,915	5,443	3,827	6,879,243	1,278	37,645	.....	63	22,071	107	46,178	90
575,637	161,085	374,528	67,224	66,308	257,785,236	6,771	618,803	6,056	221	247,647	664	552,794	91
194,938	55,974	97,578	22,894	13,679	19,722,262	2,977	108,443	.....	75	68,365	199	149,812	92
129,417	113,146	67,815	21,428	14,726	24,871,317	2,885	159,800	479	83	49,785	179	118,848	93
43,748	57,909	28,860	10,820	6,985	11,355,905	1,898	78,066	.....	44	19,030	134	76,313	94
334,984	484,169	281,692	58,889	40,711	52,546,210	8,697	779,354	2,327	290	190,129	577	350,920	95
132,964	271,642	132,280	35,715	23,118	29,966,758	7,416	428,930	.....	131	85,158	434	239,150	96
24,698	78,257	35,007	5,125	3,208	5,499,084	517	59,315	359	35	28,722	61	49,089	97
12,952	27,147	18,325	3,229	1,831	3,883,285	259	22,082	.....	13	11,950	40	34,175	98
47,251	114,996	29,192	4,741	2,449	3,390,401	67	19,818	20	27	52,350	49	79,021	99
61,247	66,971	44,612	3,583	2,192	3,430,600	152	33,877	.....	26	25,387	75	63,767	100
22,992	58,718	41,182	4,416	2,562	5,049,047	539	58,492	12	30	32,091	80	53,418	101
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	102

[1] Includes 2 stations in Hawaii and 4 in Porto Rico, in order that the operations of individual stations may not be disclosed.
[2] Hawaii included with Alaska, and Porto Rico not reported.

Digitized by Google

TABLE 118.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—PRIMARY

	STATE OR TERRITORY	Number of stations.	PRIMARY POWER.													
			Aggregate.		Steam engines.											
					Total.		500 H. P. and under.		Over 500 H. P. but under 1,000 H. P.		1,000 H. P. but under 2,000 H. P.		2,000 H. P. but under 5,000 H. P.		5,000 H. P. and over.	
			Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.
1	United States...	4,714	10,998	4,098,188	6,829	1,810,040	6,183	1,018,566	375	259,478	182	230,216	70	186,280	19	115,500
2	Alabama	55	100	26,404	76	16,835	69	10,505	4	2,430	3	3,900				
3	Arizona	15	39	7,746	25	4,286	25	4,286								
4	Arkansas	63	100	13,953	89	12,091	89	12,091								
5	California	129	384	384,673	143	98,299	107	23,469	15	10,405	5	6,025	11	23,900	5	34,500
6	Colorado	56	192	82,427	97	32,835	75	11,952	13	9,883	7	7,000	2	4,000		
7	Connecticut	41	183	56,243	99	24,357	94	20,557	5	3,800						
8	Delaware[1]	14	55	33,805	29	8,515	24	4,315	5	4,200						
9	Florida	37	75	14,370	57	10,004	56	9,254	1	750						
10	Georgia	93	142	54,704	102	16,129	101	14,879			1	1,250				
11	Idaho	42	56	13,694	19	2,202	19	2,202								
12	Illinois	383	832	299,246	654	148,248	599	85,898	30	21,950	21	26,400	3	9,000	1	5,000
13	Indiana	200	479	116,828	324	68,311	305	53,561	16	10,250	3	4,500				
14	Iowa	192	339	46,739	266	40,406	258	34,301	6	3,407	2	2,698				
15	Kansas	111	222	48,374	146	35,589	138	22,169	4	3,000	1	1,420	3	9,000		
16	Kentucky	83	158	41,984	144	32,539	127	19,439	13	8,300	4	4,800				
17	Louisiana	42	89	23,292	69	20,542	59	8,667	4	2,875	4	5,000	2	4,000		
18	Maine	81	215	57,880	74	16,293	73	15,693	1	600						
19	Maryland	36	116	51,541	81	39,035	71	12,885	4	2,650	1	1,000	4	15,000	1	7,500
20	Massachusetts	120	393	188,335	285	118,287	222	46,881	40	28,756	12	15,400	11	27,250		
21	Michigan	234	583	184,207	280	56,893	264	44,060	13	9,100	3	3,733				
22	Minnesota	171	343	121,825	220	39,895	207	27,545	8	5,200	4	5,150	1	2,000		
23	Mississippi	68	107	15,522	95	14,072	95	14,072								
24	Missouri	162	380	111,416	226	63,162	205	30,972	8	5,430	6	6,630	7	20,130		
25	Montana	33	93	68,817	28	5,805	26	3,805			2	2,000				
26	Nebraska	98	171	30,020	111	16,496	109	14,546	1	750	1	1,200				
27	Nevada	9	19	6,980	3	210	3	210								
28	New Hampshire	56	166	46,784	38	14,870	33	7,170	1	700	3	4,000	1	3,000		
29	New Jersey	64	257	93,602	184	76,095	131	28,267	31	21,050	22	26,778				
30	New Mexico	15	32	4,548	26	4,035	25	3,185	1	850						
31	New York	314	958	722,653	468	206,412	397	71,212	33	23,400	17	22,000	10	29,300	11	60,500
32	North Carolina	71	113	20,683	73	10,241	72	9,641	1	600						
33	North Dakota	29	61	10,277	55	9,820	54	9,170	1	650						
34	Ohio	272	589	179,111	460	125,335	416	67,276	22	13,977	12	16,882	10	27,200		
35	Oklahoma	72	115	22,623	109	21,599	105	18,159	3	1,940	1	1,500				
36	Oregon	61	144	126,815	57	20,077	44	7,877	6	3,800	7	8,400				
37	Pennsylvania	327	953	302,537	666	209,082	588	123,557	45	30,925	29	38,600	3	8,000	1	8,000
38	Rhode Island	7	66	27,986	22	12,480	11	3,020	9	6,460	2	3,000				
39	South Carolina	40	104	84,115	48	8,475	47	5,975					1	2,500		
40	South Dakota	37	74	12,984	40	5,952	40	5,952								
41	Tennessee	78	142	28,730	110	21,150	103	13,650	3	2,100	3	3,400	1	2,000		
42	Texas	218	415	71,914	287	49,216	268	32,916	15	11,050	4	5,250				
43	Utah	31	55	35,950	10	1,279	10	1,279								
44	Vermont	60	146	38,566	33	7,981	30	6,131	3	1,850						
45	Virginia	51	85	14,619	38	4,868	38	4,868								
46	Washington	71	114	67,224	49	9,514	46	6,864	2	1,350	1	1,300				
47	West Virginia	48	95	21,428	65	13,811	61	11,011	3	1,800	1	1,000				
48	Wisconsin	206	409	58,889	220	32,327	215	29,087	5	3,240						
49	Wyoming	18	40	5,125	29	4,085	29	4,085								
50	Alaska	9	26	4,741	14	2,231	14	2,231								
51	Hawaii and Porto Rico	6	22	4,416	13	3,190	13	3,190								

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

POWER AND GENERATING EQUIPMENT, BY STATES AND TERRITORIES: 1907.

PRIMARY POWER—continued.

Steam turbines.												Water wheels.								
Total.		500 H. P. and under.		Over 500 H. P. but under 1,000 H. P.		1,000 H. P. but under 2,000 H. P.		2,000 H. P. but under 5,000 H. P.		5,000 H. P. and over.		Total.		500 H. P. and under.		Over 500 H. P. but under 1,000 H. P.		1,000 H. P. but under 2,000 H. P.		
Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	
377	817,410	65	17,017	123	85,680	67	86,372	78	221,415	44	406,926	2,481	1,349,067	1,910	320,636	244	161,051	161	196,620	1
4	2,392	1	225	3	2,167	.....	.....	.....	.....	.....	.....	15	7,007	11	1,007	.....	.....	4	6,000	2
5	2,550	3	1,000	2	1,550	.....	.....	.....	.....	.....	.....	4	750	4	750	.....	.....	.....	.....	3
2	1,225	.....	.....	2	1,225	.....	.....	.....	.....	.....	.....	1	300	1	300	.....	.....	.....	.....	4
13	35,000	1	390	2	1,500	2	2,500	6	16,610	2	14,000	172	208,444	80	17,519	18	14,225	35	41,400	5
13	22,166	1	225	3	2,041	4	5,500	5	14,400	.....	.....	47	25,580	32	5,480	6	3,900	6	6,600	6
12	12,886	3	950	3	2,036	6	9,900	.....	.....	.....	.....	54	18,045	48	8,045	.....	.....	6	10,000	7
8	23,800	2	1,000	1	800	1	1,000	2	6,000	2	15,000	5	285	5	285	.....	.....	.....	.....	8
11	4,200	8	1,200	.....	.....	3	3,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
1	2,000	.....	.....	.....	.....	.....	.....	1	2,000	.....	.....	37	36,335	15	2,335	4	3,000	11	14,200	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	37	11,492	34	8,742	1	750	2	2,000	11
27	138,710	.....	.....	10	6,710	4	5,300	3	10,200	10	116,500	80	10,478	80	10,478	.....	.....	.....	.....	12
25	25,861	3	187	13	9,324	4	4,650	5	11,700	.....	.....	83	19,606	83	19,606	.....	.....	.....	.....	13
2	1,500	.....	.....	2	1,500	.....	.....	.....	.....	.....	.....	44	3,833	44	3,833	.....	.....	.....	.....	14
2	1,500	.....	.....	2	1,500	.....	.....	.....	.....	.....	.....	36	8,661	36	8,661	.....	.....	.....	.....	15
3	9,125	1	125	.....	.....	.....	.....	2	9,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
2	1,825	.....	.....	1	525	1	1,300	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
1	750	.....	.....	1	750	.....	.....	.....	.....	.....	.....	132	39,766	103	15,442	25	19,104	4	5,220	18
7	10,866	2	700	1	666	1	1,500	3	8,000	.....	.....	13	1,347	13	1,347	.....	.....	.....	.....	19
22	51,330	2	550	7	4,930	7	8,800	3	7,050	3	30,000	58	16,781	49	8,562	7	5,519	2	2,700	20
17	40,215	2	875	5	3,540	2	3,300	8	32,500	.....	.....	249	85,738	174	24,038	70	38,500	1	1,200	21
8	8,200	4	1,500	.....	.....	2	2,700	2	4,000	.....	.....	71	71,656	57	8,656	2	1,400	5	5,800	22
1	750	.....	.....	1	750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23
10	38,882	.....	.....	2	1,342	.....	.....	4	10,720	4	26,820	5	2,002	2	202	3	1,800	.....	.....	24
3	6,025	.....	.....	1	625	.....	.....	2	5,400	.....	.....	62	56,987	34	6,432	5	4,125	15	17,150	25
4	8,750	.....	.....	1	750	.....	.....	3	8,000	.....	.....	19	2,954	18	2,154	1	800	.....	.....	26
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	6,260	3	310	5	3,750	.....	.....	27
6	4,390	.....	.....	6	4,390	.....	.....	.....	.....	.....	.....	101	25,404	90	14,504	3	2,400	8	8,500	28
10	12,850	.....	.....	2	1,500	7	7,350	1	4,000	.....	.....	22	1,794	22	1,794	.....	.....	.....	.....	29
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	513	6	513	.....	.....	.....	.....	30
47	203,595	6	1,270	8	5,072	4	5,160	12	30,093	17	162,000	362	305,950	256	44,468	32	20,782	25	31,400	31
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	32	9,962	20	3,012	12	6,950	.....	.....	32
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	100	1	100	.....	.....	.....	.....	33
20	44,916	4	1,250	6	4,500	4	5,166	3	11,500	3	22,500	21	2,037	21	2,037	.....	.....	.....	.....	34
1	750	.....	.....	1	750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35
2	4,000	.....	.....	.....	.....	.....	.....	2	4,000	.....	.....	72	102,052	38	6,286	6	4,266	3	3,000	36
39	49,081	7	1,675	21	14,345	5	6,433	3	6,522	3	20,106	119	30,863	110	23,063	4	2,780	5	5,000	37
6	12,020	.....	.....	.....	.....	2	2,300	4	9,720	.....	.....	16	2,263	16	2,263	.....	.....	.....	.....	38
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	52	75,430	21	8,705	7	4,500	16	20,625	39
5	4,100	3	1,100	.....	.....	2	3,000	.....	.....	.....	.....	12	2,205	10	1,005	2	1,200	.....	.....	40
6	5,360	.....	.....	4	2,680	2	2,680	.....	.....	.....	.....	14	1,240	14	1,240	.....	.....	.....	.....	41
11	15,136	3	1,100	1	536	3	3,500	4	10,000	.....	.....	23	2,762	23	2,762	.....	.....	.....	.....	42
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	45	34,671	27	4,571	7	4,700	8	10,600	43
2	1,783	1	450	.....	.....	1	1,333	.....	.....	.....	.....	101	28,472	87	17,222	13	9,050	.....	.....	44
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	44	9,551	40	5,726	1	600	3	3,225	45
3	1,160	2	410	1	750	.....	.....	.....	.....	.....	.....	48	56,118	28	6,018	7	4,700	2	2,000	46
5	2,680	2	410	3	2,270	.....	.....	.....	.....	.....	.....	11	3,627	9	1,927	2	1,700	.....	.....	47
10	4,856	3	200	7	4,656	.....	.....	.....	.....	.....	.....	140	19,001	139	18,451	1	550	.....	.....	48
1	225	1	225	.....	.....	.....	.....	.....	.....	.....	.....	6	765	6	765	.....	.....	.....	.....	49
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10	2,490	10	2,490	.....	.....	.....	.....	50
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	1,186	8	1,186	.....	.....	.....	.....	51

Digitized by Google

TABLE 118.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—PRIMARY

	STATE OR TERRITORY	PRIMARY POWER—continued.								GENERATING AND OTHER MAIN-STATION EQUIPMENT.					
		Water wheels—Continued.				Gas engines.		Auxiliary engines.		Dynamos.					
		2,000 H. P. but under 5,000 H. P.		5,000 H. P. and over.						Aggregate.					
										Total.		Under 200 K. W.		200 K. W. but under 500 K. W.	
		Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.
1	United States	111	330,980	55	339,800	463	55,828	848	65,823	12,173	2,709,225	9,491	664,440	1,547	434,586
2	Alabama					1	20	4	150	104	17,124	78	6,309	18	4,490
3	Arizona					3	70	2	90	53	4,939	44	2,114	7	1,825
4	Arkansas					1	12	7	325	105	9,678	96	6,803	8	2,375
5	California	32	89,600	7	45,700	11	16,585	45	26,345	336	238,480	131	10,232	88	26,035
6	Colorado	3	9,600			4	300	31	1,546	181	53,130	121	7,605	26	7,025
7	Connecticut					6	706	12	249	220	39,363	175	13,568	25	6,405
8	Delaware[1]							13	1,205	82	26,733	57	3,917	14	4,216
9	Florida					1	40	6	126	74	7,804	67	6,059	7	1,745
10	Georgia	7	16,800			1	140	1	100	157	35,446	122	9,501	13	2,795
11	Idaho									46	7,082	34	2,632	7	1,950
12	Illinois					19	870	52	940	947	209,226	819	56,026	70	21,750
13	Indiana					15	1,295	32	1,755	540	81,576	435	31,016	71	19,310
14	Iowa					11	564	16	436	374	32,056	343	21,342	25	6,864
15	Kansas					19	1,678	19	946	230	30,307	192	12,972	25	6,835
16	Kentucky					1	15	10	305	175	29,140	140	9,355	23	5,985
17	Louisiana					3	420	15	505	86	15,175	65	4,275	12	3,700
18	Maine							8	1,071	210	39,290	142	9,420	44	12,750
19	Maryland					5	130	10	163	155	36,223	120	7,393	21	4,930
20	Massachusetts					12	1,097	16	840	614	135,924	463	33,440	87	26,509
21	Michigan			4	22,000	11	603	26	758	544	101,714	430	28,813	74	21,901
22	Minnesota	4	16,800	3	39,000	22	1,428	22	646	381	78,516	322	19,786	35	9,690
23	Mississippi					1	25	10	675	102	9,884	88	6,609	13	2,775
24	Missouri					13	963	126	6,407	295	68,467	254	17,142	18	5,175
25	Montana	8	29,280							94	39,602	51	3,442	20	5,710
26	Nebraska					17	845	20	975	171	20,041	156	9,461	9	2,130
27	Nevada	1	2,200			6	485	1	25	14	5,690	9	490		
28	New Hampshire					8	1,115	13	1,005	140	31,917	82	7,297	35	8,370
29	New Jersey					11	1,328	30	1,535	345	70,566	224	18,056	82	21,285
30	New Mexico									38	3,789	35	2,764	2	525
31	New York	24	62,800	25	146,500	26	3,315	55	3,381	1,072	482,031	746	57,609	160	48,661
32	North Carolina							8	480	125	13,911	108	7,836	13	3,575
33	North Dakota					2	205	3	152	64	5,819	58	4,349	6	1,470
34	Ohio					53	5,628	35	1,195	756	126,533	633	44,003	78	21,630
35	Oklahoma					2	200	3	74	122	15,499	94	7,349	25	6,150
36	Oregon	22	73,500	3	15,000	6	182	7	504	113	32,587	59	3,837	35	10,995
37	Pennsylvania					66	7,469	63	6,042	1,285	212,543	1,028	75,741	158	45,267
38	Rhode Island					4	1,000	18	223	110	21,040	88	5,395	5	1,295
39	South Carolina			8	41,600	1	150	3	60	87	51,271	49	3,621	5	1,350
40	South Dakota					10	528	7	199	70	10,046	62	4,801	3	745
41	Tennessee							12	980	127	20,911	101	7,001	12	3,050
42	Texas					53	3,058	41	1,742	451	48,558	391	21,863	42	10,745
43	Utah	3	14,800							62	33,592	36	2,192	8	2,100
44	Vermont	1	2,200			4	205	6	125	118	21,854	73	5,481	37	10,023
45	Virginia					1	60	2	140	83	9,195	73	5,295	7	1,650
46	Washington	6	13,400	5	30,000	2	90	12	342	128	66,308	83	6,678	20	5,930
47	West Virginia					9	925	5	385	115	14,726	91	6,681	18	4,845
48	Wisconsin					22	2,079	17	626	432	40,711	385	24,136	34	9,575
49	Wyoming							4	50	40	3,208	38	2,733	2	475
50	Alaska							2	20	25	2,449	22	1,574	3	875
51	Hawaii and Porto Rico							1	40	24	2,562	21	1,662	3	900

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

POWER AND GENERATING EQUIPMENT, BY STATES AND TERRITORIES: 1907—Continued.

GENERATING AND OTHER MAIN-STATION EQUIPMENT—continued.																		
Dynamos—Continued.																		
Aggregate—Continued.								Direct-current, constant-voltage.										
500 K. W. but under 1,000 K. W.		1,000 K. W. but under 2,000 K. W.		2,000 K. W. but under 5,000 K. W.		5,000 K. W. and over.		Total.		Under 200 K. W.		200 K. W. but under 500 K. W.		500 K. W. but under 1,000 K. W.		1,000 K. W. but under 2,000 K. W.		2,000 K. W. but under 5,000 K. W.		
Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	
624	390,149	281	351,700	163	438,350	67	430,000	3,680	406,460	3,128	183,865	417	115,155	102	63,890	30	36,550	3	7,000	1
6	4,125	2	2,200	.....	.....	.....	.....	29	4,300	21	1,550	7	1,750	.....	.....	1	1,000	.....	.....	2
2	1,000	.....	.....	.....	.....	.....	.....	27	737	27	737	.....	.....	.....	.....	.....	.....	.....	.....	3
1	500	.....	.....	.....	.....	.....	.....	36	2,331	33	1,531	3	800	.....	.....	.....	.....	.....	.....	4
50	35,213	31	43,000	22	51,500	14	72,500	68	8,950	46	2,125	20	5,105	1	720	1	1,000	.....	.....	5
20	12,550	7	8,700	7	17,250	.....	.....	57	4,852	46	2,102	11	2,750	.....	.....	.....	.....	.....	.....	6
7	3,890	12	13,500	1	2,000	.....	.....	70	7,097	64	5,847	6	1,250	.....	.....	.....	.....	.....	.....	7
6	3,600	1	1,000	2	4,000	2	10,000	36	5,280	25	1,730	10	2,950	1	600	.....	.....	.....	.....	8
.....	.....	.....	.....	.....	.....	.....	.....	10	1,070	8	570	2	500	.....	.....	.....	.....	.....	.....	9
9	5,750	13	17,400	.....	.....	.....	.....	23	1,469	20	819	3	650	.....	.....	.....	.....	.....	.....	10
5	2,500	.....	.....	.....	.....	.....	.....	9	147	9	147	.....	.....	.....	.....	.....	.....	.....	.....	11
31	19,150	13	14,300	4	11,000	10	87,000	283	34,374	237	13,764	38	13,310	6	3,800	1	1,000	1	2,500	12
21	12,650	12	16,600	1	2,000	.....	.....	126	13,528	108	6,778	14	3,250	3	2,000	1	1,500	.....	.....	13
5	2,850	1	1,000	.....	.....	.....	.....	168	11,866	158	8,016	8	2,050	1	800	1	1,000	.....	.....	14
10	5,500	2	3,000	1	2,000	.....	.....	76	6,836	68	3,876	5	1,460	3	1,500	.....	.....	.....	.....	15
8	4,550	1	1,000	3	8,250	.....	.....	57	5,509	50	2,709	6	2,000	1	800	.....	.....	.....	.....	16
6	4,100	3	3,100	.....	.....	.....	.....	38	5,724	32	1,774	2	800	3	2,100	1	1,050	.....	.....	17
23	16,120	1	1,000	.....	.....	.....	.....	56	5,714	48	2,849	4	865	4	2,000	.....	.....	.....	.....	18
5	3,400	1	1,500	7	14,000	1	5,000	33	2,574	28	1,574	5	1,000	.....	.....	.....	.....	.....	.....	19
40	24,125	20	27,100	1	2,250	3	22,500	165	26,633	134	9,808	17	4,450	10	5,975	4	6,400	.....	.....	20
14	7,500	18	20,500	8	23,000	.....	.....	127	11,562	110	5,587	15	4,475	1	500	1	1,000	.....	.....	21
7	4,540	10	12,000	4	10,000	3	22,500	185	13,009	171	8,484	13	3,525	.....	.....	1	1,000	.....	.....	22
1	500	.....	.....	.....	.....	.....	.....	22	1,051	22	1,051	.....	.....	.....	.....	.....	.....	.....	.....	23
9	4,650	3	4,500	7	17,000	4	20,000	102	10,215	91	4,105	3	960	7	3,650	1	1,500	.....	.....	24
15	10,250	.....	.....	8	20,200	.....	.....	25	2,166	22	1,466	3	700	.....	.....	.....	.....	.....	.....	25
2	1,250	2	2,700	2	4,500	.....	.....	74	4,005	71	3,230	3	775	.....	.....	.....	.....	.....	.....	26
4	3,000	.....	.....	1	2,200	.....	.....	3	60	3	60	.....	.....	.....	.....	.....	.....	.....	.....	27
18	10,050	4	4,200	1	2,000	.....	.....	26	3,682	19	1,232	4	950	3	1,500	.....	.....	.....	.....	28
31	21,225	7	7,000	1	3,000	.....	.....	91	21,114	37	2,564	41	9,450	12	8,100	1	1,000	.....	.....	29
1	500	.....	.....	.....	.....	.....	.....	17	925	17	925	.....	.....	.....	.....	.....	.....	.....	.....	30
59	39,111	39	47,800	49	155,350	19	133,500	291	48,768	224	17,998	44	13,050	18	12,720	5	5,000	.....	.....	31
4	2,500	.....	.....	.....	.....	.....	.....	32	1,956	30	1,556	2	400	.....	.....	.....	.....	.....	.....	32
.....	.....	.....	.....	.....	.....	.....	.....	45	3,609	42	2,989	3	620	.....	.....	.....	.....	.....	.....	33
23	13,700	13	16,700	6	15,500	3	15,000	230	34,298	195	11,998	23	8,000	5	3,600	6	8,200	1	2,500	34
2	1,000	1	1,000	.....	.....	.....	.....	32	3,120	27	1,770	5	1,350	.....	.....	.....	.....	.....	.....	35
14	8,255	5	9,500	.....	.....	.....	.....	24	3,877	15	352	7	2,100	2	1,425	.....	.....	.....	.....	36
70	42,635	24	26,900	1	2,000	4	20,000	388	48,682	315	22,867	61	17,165	9	5,150	3	3,500	.....	.....	37
13	7,100	2	3,000	2	4,250	.....	.....	35	8,374	23	2,079	5	1,295	6	3,000	.....	.....	1	2,000	38
16	11,500	9	10,800	8	24,000	.....	.....	5	191	5	191	.....	.....	.....	.....	.....	.....	.....	.....	39
3	1,500	2	3,000	.....	.....	.....	.....	23	1,456	23	1,456	.....	.....	.....	.....	.....	.....	.....	.....	40
10	5,860	3	3,000	1	2,000	.....	.....	30	2,176	27	1,176	2	500	1	500	.....	.....	.....	.....	41
11	6,950	7	9,000	.....	.....	.....	.....	209	12,070	194	7,345	12	2,775	3	1,950	.....	.....	.....	.....	42
10	6,700	2	2,000	4	9,600	2	11,000	13	522	13	522	.....	.....	.....	.....	.....	.....	.....	.....	43
6	3,350	1	1,000	1	2,000	.....	.....	11	863	9	463	2	400	.....	.....	.....	.....	.....	.....	44
3	2,250	.....	.....	.....	.....	.....	.....	22	1,252	22	1,252	.....	.....	.....	.....	.....	.....	.....	.....	45
4	2,500	9	12,700	10	27,500	2	11,000	30	5,484	24	1,184	2	400	2	1,500	2	2,400	.....	.....	46
6	3,200	.....	.....	.....	.....	.....	.....	31	2,255	30	2,055	1	200	.....	.....	.....	.....	.....	.....	47
13	7,000	.....	.....	.....	.....	.....	.....	172	9,804	167	8,679	5	1,125	.....	.....	.....	.....	.....	.....	48
.....	.....	.....	.....	.....	.....	.....	.....	18	923	18	923	.....	.....	.....	.....	.....	.....	.....	.....	49
.....	.....	.....	.....	.....	.....	.....	.....	10	419	10	419	.....	.....	.....	.....	.....	.....	.....	.....	50
.....	.....	.....	.....	.....	.....	.....	.....	11	797	10	597	1	200	.....	.....	.....	.....	.....	.....	51

Digitized by Google

TABLE 118.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—PRIMARY

STATE OR TERRITORY	GENERATING AND OTHER MAIN-STATION EQUIPMENT—continued. Dynamos—Continued. Direct-current, constant-amperage. Total.		Under 200 K. W.		200 K. W. but under 500 K. W.		500 K. W. but under 1,000 K. W.		1,000 K. W. but under 2,000 K. W.		Alternating single-phase and poly-phase current. Total.		Under 200 K. W.	
	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.
1 United States	1,653	98,992	1,604	71,649	16	4,533	3	2,010	2	2,500	6,808	2,221,773	4,699	498,926
2 Alabama	1	[illegible]	1	[illegible]							[illegible]	[illegible]	56	4,717
3 Arizona	1	[illegible]	1	[illegible]							[illegible]	4,172	16	1,337
4 Arkansas	1	[illegible]	1	[illegible]							[illegible]	[illegible]	50	5,004
5 California	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	50	7,935
6 Colorado	[illegible]	[illegible]	[illegible]	1,[illegible]							105	61,101	56	4,336
7 Connecticut	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	60	6,671
8 Delaware	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	15	1,575
9 Florida	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	35	2,065
10 Georgia	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	52	2,459
11 Idaho	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	6,935	15	2,465
12 Illinois	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]
13 Indiana	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
14 Iowa	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
15 Kansas	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
16 Kentucky	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
17 Louisiana	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
18 Maine	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]
19 Maryland	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
20 Massachusetts	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
21 Michigan	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
22 Minnesota	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
23 Mississippi	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
24 Missouri	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
25 Montana	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
26 Nebraska	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
27 Nevada	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
28 New Hampshire	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
29 New Jersey	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
30 New Mexico	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
31 New York	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32 North Carolina	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
33 North Dakota	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
34 Ohio	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
35 Oklahoma	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
36 Oregon	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
37 Pennsylvania	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
38 Rhode Island	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
39 South Carolina	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
40 South Dakota	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
41 Tennessee	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
42 Texas	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
43 Utah	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
44 Vermont	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	[illegible]	[illegible]
45 Virginia	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
46 Washington	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
47 West Virginia	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
48 Wisconsin	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
49 Wyoming	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
50 Alaska	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]
51 Hawaii and Porto Rico	[illegible]	[illegible]	[illegible]	[illegible]							[illegible]	[illegible]	[illegible]	[illegible]

[illegible] Includes [illegible] station in Panama or Columbia. In order that the operations of individual stations may not be disclosed

Digitized by Google

POWER AND GENERATING EQUIPMENT, BY STATES AND TERRITORIES: 1907—Continued.

GENERATING AND OTHER MAIN-STATION EQUIPMENT—continued.																	
Dynamos—Continued.										Transformers.		Boosters.		Rotaries.		Storage-battery cells in main stations.	Kilowatt capacity of miscellaneous apparatus.	
Alternating single-phase and polyphase current—Continued.																		
200 K. W. but under 500 K. W.		500 K. W. but under 1,000 K.W.		1,000 K. W. but under 2,000 K.W.		2,000 K. W. but under 5,000 K.W.		5,000 K. W. and over.										
Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.			
1,114	314,598	519	324,249	249	312,650	160	431,350	67	430,000	1,577	592,708	127	4,810	180	52,416	9,751	43,209	1
11	2,740	6	4,125	1	1,200					12	3,801			2	600		15	2
7	1,825	2	1,000							2	266	3	85	2	300		16	3
5	1,575	1	500											2	680		45	4
68	20,930	49	34,493	30	42,000	22	51,500	14	72,500	268	131,575	4	136	6	2,000	118	70	5
15	4,275	20	12,550	7	8,700	7	17,250			73	21,251	7	414	1	350	268	470	6
19	5,155	7	3,890	12	13,500	1	2,000			10	6,885	2	250	2	300		60	7
4	1,266	5	3,000	1	1,000	2	4,000	2	10,000	3	130	4	266	1	500	204	2,670	8
5	1,245									21	290			1	275		12	9
10	2,145	9	5,750	13	17,400					17	15,900	1	22				25	10
7	1,950	5	2,500							22	2,690	1	40				19	11
30	7,940	25	15,350	12	13,300	3	8,500	10	87,000	53	4,656	13	324	13	3,695	1,285	1,898	12
55	15,292	18	10,650	11	15,100	1	2,000			43	3,749			9	2,338		80	13
17	4,814	4	2,050							12	486	2	25	4	866	572	420	14
20	5,375	7	4,000	2	3,000	1	2,000			42	6,517	1	30			280	1,043	15
17	3,985	7	3,750	1	1,000	3	8,250			9	504	5	22				115	16
10	2,900	3	2,000	2	2,050							1	10	3	650	36		17
38	11,320	19	14,120	1	1,000					23	10,648	1	60					18
16	3,930	5	3,400	1	1,500	7	14,000	1	5,000	4	160	3	26	1	300	228	200	19
70	22,059	30	18,150	16	20,700	1	2,250	3	22,500	46	2,871	4	202	7	2,000	67	860	20
59	17,426	13	7,000	17	19,500	8	23,000			55	20,484	9	272	21	6,100	646	1,178	21
22	6,165	7	4,540	9	11,000	4	10,000	3	22,500	48	40,172	6	104			376	1,353	22
13	2,775	1	500							4	102	2	15	2	600		20	23
15	4,215	2	1,000	2	3,000	7	17,000	4	20,000	12	377	2	15	1	200	203	95	24
17	5,010	15	10,250			8	20,200			40	34,175	3	45	1	200		795	25
6	1,355	2	1,250	2	2,700	2	4,500			4	152	1	2	3	1,300	60		26
		4	3,000			1	2,200			12	4,200	1	8	1	500	64		27
31	7,420	15	8,550	4	4,200	1	2,000			6	300					236	7	28
41	11,835	19	13,125	6	6,000	1	3,000			10	132	7	566	11	3,835	974	584	29
2	525	1	500							3	22						2	30
112	34,211	39	25,141	32	40,300	49	155,350	19	133,500	263	92,538	22	570	27	7,914	1,199	18,988	31
11	3,175	4	2,500							9	1,664	1	30					32
3	850													2	108		289	33
55	13,630	18	10,100	7	8,500	5	13,000	3	15,000	42	11,820	5	150	8	2,975	610	4,063	34
20	4,800	2	1,000	1	1,000					8	231	1	7				350	35
28	8,895	12	6,830	5	9,500					42	13,397						625	36
92	26,802	60	36,725	21	23,400	1	2,000	4	20,000	74	21,666	3	238	20	4,470	991	4,354	37
		7	4,100	2	3,000	1	2,250			34	3,225	5	462	5	2,100	548		38
5	1,350	16	11,500	9	10,800	8	24,000			43	29,788						55	39
3	745	3	1,500	2	3,000					5	1,250			1	150	266		40
10	2,550	9	5,360	3	3,000	1	2,000			12	2,605	1	4	7	2,300		885	41
30	7,970	8	5,000	7	9,000					8	429	2	240	7	1,700		535	42
8	2,100	10	6,700	2	2,000	4	9,600	2	11,000	56	35,762							43
34	9,323	6	3,350	1	1,000	1	2,000			36	4,408					189		44
7	1,650	3	2,250														37	45
18	5,530	2	1,000	7	10,300	10	27,500	2	11,000	62	56,643	2	151	5	1,510	55	208	46
17	4,645	6	3,200							13	1,564						433	47
29	8,450	13	7,000							16	3,203	2	19	4	1,600	276	320	48
2	475																15	49
3	875									6	900							50
2	700													1	250			51

Digitized by Google

TABLE 119.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—SUBSTATION EQUIPMENT, MOTORS,

	STATE OR TERRITORY.	Number of stations.	SUBSTATION PLANTS.						
			Total kilowatt capacity.	Transformers.		Rotaries.		Number of cells in storage batteries.	Kilowatt capacity of miscellaneous apparatus.
				Number	Kilowatts.	Number.	Kilowatts.		
1	United States	4,714	1,511,102	4,211	1,100,824	490	311,003	20,187	99,275
2	Alabama	55	4,500	9	3,400			256	1,100
3	Arizona	15	1,490	9	1,190	2	300		
4	Arkansas	63							
5	California	129	296,306	1,068	283,428	8	2,130	1,156	10,748
6	Colorado	56	19,594	90	18,910	1	400		284
7	Connecticut	41	16,520	44	11,470	11	5,050	1,040	
8	Delaware[1]	14	24,795	21	11,900	18	10,700	1,178	2,195
9	Florida	37							
10	Georgia	93	15,583	39	14,483	4	600		500
11	Idaho	42	4,225	61	3,925				300
12	Illinois	383	92,651	158	21,351	93	69,400	3,618	1,900
13	Indiana	200	23,611	52	19,996	12	1,615	420	2,056
14	Iowa	192	1,443	28	1,411				32
15	Kansas	111	5,850	28	5,850				
16	Kentucky	83	1,200						1,200
17	Louisiana	42	6,117	10	2,117	4	3,000		1,000
18	Maine	81	12,108	65	12,108				
19	Maryland	36	16,525	26	5,725	9	7,400		3,400
20	Massachusetts	120	24,093	163	22,181	3	900	1,388	12
21	Michigan	234	88,858	143	61,040	28	9,290	290	18,528
22	Minnesota	171	53,282	77	44,440	16	5,100	528	3,752
23	Mississippi	68	60	2	60				
24	Missouri	162	35,272	116	6,347	16	7,950	936	20,975
25	Montana	33	17,742	54	16,602	2	600		540
26	Nebraska	98	890	17	840				50
27	Nevada	9	7,700	34	7,700				
28	New Hampshire	56	10,805	58	9,855	3	750	278	200
29	New Jersey	64	9,070	60	4,745	14	4,200		125
30	New Mexico	15							
31	New York	314	487,973	865	316,987	196	161,628	7,761	9,408
32	North Carolina	71	2,250	24	2,250				
33	North Dakota	29							
34	Ohio	272	18,795	63	13,425	4	1,000	470	4,370
35	Oklahoma	72							
36	Oregon	61	40,829	139	29,629	15	10,200		1,000
37	Pennsylvania	337	53,747	185	36,107	23	5,440	1,108	12,200
38	Rhode Island	7	1,823	26	1,823			296	
39	South Carolina	40	47,813	158	47,813				
40	South Dakota	37	1,390	9	1,390				
41	Tennessee	78	334	12	334				
42	Texas	218	1,140						1,140
43	Utah	31	8,840	48	8,840				
44	Vermont	60	8,728	66	8,528	1	200		
45	Virginia	51	2,055	12	2,055				
46	Washington	71	38,507	114	35,357	7	3,150	55	
47	West Virginia	48	1,805	19	1,805				
48	Wisconsin	206	4,733	38	2,483				2,250
49	Wyoming	18	50	1	50				
50	Alaska	9	900	6	900				
51	Hawaii and Porto Rico	6							

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TRANSFORMERS, METERS, CUSTOMERS, AND OUTPUT OF STATIONS, BY STATES AND TERRITORIES: 1907.

STATIONARY MOTORS.		TRANSFORMERS IN CIRCUITS FOR CUSTOMERS.		Number of meters on consumption circuits.	Number of customers furnished electric current.	OUTPUT OF STATIONS, KILOWATT HOURS.		
Number.	Horsepower.	Number.	Kilowatts.			Total for year.	Average per day.	
167,184	1,649,026	299,489	2,058,567	1,683,917	1,946,979	5,862,276,737	16,295,709	1
541	5,650	2,037	8,890	11,436	16,261	30,846,764	85,766	2
339	2,220	605	3,083	5,025	5,854	9,392,302	25,731	3
198	1,177	1,917	7,396	6,503	12,071	11,519,316	31,791	4
11,560	200,067	21,625	213,633	143,384	173,029	661,606,309	1,816,169	5
3,232	41,161	4,046	45,633	41,050	46,911	123,275,212	339,288	6
2,741	21,146	3,657	24,262	20,072	21,514	67,406,232	184,720	7
1,630	13,053	1,546	8,078	11,760	11,165	30,543,522	83,681	8
189	1,584	2,004	8,183	7,970	10,540	11,765,994	32,606	9
410	11,078	3,225	14,385	10,075	15,452	59,311,202	163,252	10
406	4,064	2,011	10,402	7,160	12,656	9,577,588	27,963	11
21,675	137,661	20,331	99,067	146,208	167,645	467,657,328	1,284,805	12
5,132	33,716	12,296	63,799	72,483	86,237	130,263,693	362,484	13
2,643	14,547	4,907	23,422	39,492	48,516	37,729,072	103,743	14
1,425	12,033	3,111	15,606	21,364	29,292	59,740,179	164,756	15
1,124	9,962	4,582	20,175	18,350	24,282	37,232,623	103,293	16
1,713	16,110	3,372	8,862	15,116	15,972	26,421,316	72,841	17
1,304	19,372	4,858	24,210	16,230	19,614	66,136,651	190,339	18
4,893	19,803	3,824	22,355	20,854	22,168	47,868,675	131,146	19
15,877	81,246	16,165	94,324	87,824	80,713	219,425,607	601,777	20
7,089	53,245	10,222	72,663	78,950	87,500	208,154,199	571,182	21
3,711	41,095	6,249	35,860	46,701	54,214	87,579,431	370,445	22
181	1,520	1,958	9,791	9,234	13,829	15,704,624	43,246	23
8,923	54,111	9,531	46,185	50,670	61,575	147,328,446	406,919	24
971	33,240	1,823	33,691	15,105	17,630	137,379,261	392,207	25
1,719	10,776	2,433	17,146	22,710	27,086	31,958,739	87,804	26
411	6,850	836	4,319	2,305	3,958	29,621,730	81,820	27
1,061	10,231	4,030	18,836	11,764	14,082	55,258,921	153,562	28
5,994	27,604	13,830	56,770	55,296	57,179	140,527,522	385,866	29
195	1,231	303	1,949	2,701	4,494	4,614,349	12,680	30
18,051	393,955	32,466	496,046	217,462	201,701	1,452,222,471	3,988,701	31
249	4,345	1,526	6,395	6,068	9,719	13,171,681	37,443	32
327	1,816	343	1,752	6,493	7,999	8,229,765	22,641	33
13,083	64,941	18,991	91,064	92,964	100,071	217,311,924	599,779	34
1,086	6,586	2,259	12,052	13,937	20,565	24,985,903	69,428	35
2,072	20,452	3,439	25,227	21,312	33,475	92,807,992	255,833	36
10,063	122,461	37,578	195,742	142,186	160,957	416,554,167	1,161,309	37
2,082	12,947	2,477	16,364	13,212	11,591	35,651,323	97,675	38
969	37,388	2,456	11,195	6,632	8,054	68,696,424	175,540	39
279	3,649	823	7,096	6,500	7,940	13,615,015	40,322	40
1,193	4,524	3,009	12,527	11,397	16,426	34,847,956	101,203	41
4,223	18,634	8,893	31,744	47,625	68,447	75,829,108	210,588	42
406	5,519	943	8,233	2,197	11,212	61,672,661	169,550	43
776	9,778	3,498	20,796	12,698	15,361	29,923,333	82,149	44
268	3,690	1,295	7,764	2,835	6,969	10,208,360	29,347	45
1,933	29,686	3,843	63,657	38,699	46,452	257,785,236	708,034	46
340	4,432	2,052	10,327	5,936	9,404	24,871,317	71,643	47
2,366	17,995	5,993	25,710	34,773	44,081	52,546,210	147,562	48
131	685	271	1,901	3,199	5,116	5,499,084	15,080	49
65	587	538	1,614	734	1,879	3,390,401	9,366	50
162	1,082	420	2,002	2,490	5,059	5,049,047	13,833	51

Digitized by Google

TABLE 120.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC

	STATE OR TERRITORY.	Number of stations.	ARC LIGHTING—NUMBER OF LAMPS WIRED FOR SERVICE.											
			Total.				Direct-current.				Alternating-current.			
			Aggregate.	Commercial.		Public.		Commercial.		Public.		Commercial.		Public.
				Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.
1	United States	4,714	555,713	12,007	254,315	66,879	222,512	10,050	126,251	64,416	68,500	1,957	128,064	2,463	154,012
2	Alabama	55	4,926	265	2,483	68	2,110	.....	1,780	2	119	265	703	66	1,991
3	Arizona	15	754	78	409	27	240	6	106	9	27	72	303	18	213
4	Arkansas	63	1,669	3	583	9	1,074	3	21	9	445	.....	562	.....	629
5	California	129	19,691	195	9,239	903	9,354	66	984	652	411	129	8,255	251	8,943
6	Colorado	56	5,391	88	2,230	1,692	1,381	88	75	1,692	67	.....	2,155	.....	1,314
7	Connecticut	41	7,639	241	3,410	1,371	2,617	229	1,849	1,371	589	12	1,561	.....	2,028
8	Delaware[1]	14	4,473	37	2,601	363	1,472	37	1,989	363	1,373	.....	612	.....	99
9	Florida	37	1,408	144	128	220	916	144	12	200	24	.....	116	20	892
10	Georgia	93	3,173	.....	561	310	2,302	.....	33	183	78	.....	528	127	2,224
11	Idaho	42	966	.....	379	24	563	.....	.....	5	3	.....	379	19	560
12	Illinois	383	55,309	683	26,411	9,225	18,990	630	14,462	9,107	5,238	53	11,949	118	13,752
13	Indiana	200	22,165	149	8,894	4,544	8,578	103	3,429	4,491	2,400	46	5,465	53	6,178
14	Iowa	192	7,352	75	3,394	979	2,904	73	1,730	908	988	2	1,664	71	1,916
15	Kansas	111	5,685	3	2,514	269	2,899	2	889	269	791	1	1,625	.....	2,108
16	Kentucky	83	6,884	.....	1,556	318	5,010	.....	136	318	2,666	.....	1,420	.....	2,344
17	Louisiana	42	8,587	.....	4,440	.....	4,147	.....	3,115	.....	246	.....	1,325	.....	3,901
18	Maine	81	3,187	15	1,096	326	1,750	15	290	326	550	.....	806	.....	1,200
19	Maryland	36	9,292	383	5,544	1,146	2,219	383	3,138	1,146	1,837	.....	2,406	.....	382
20	Massachusetts	120	33,869	155	15,991	2,741	14,982	155	8,697	2,634	6,674	.....	7,294	107	8,308
21	Michigan	234	23,514	195	9,335	2,826	11,158	163	4,235	2,511	2,361	32	5,100	315	8,797
22	Minnesota	171	13,398	9	8,138	1,648	3,603	9	5,266	1,561	1,086	.....	2,872	87	2,517
23	Mississippi	68	1,694	14	361	31	1,288	.....	32	.....	82	14	329	31	1,206
24	Missouri	162	17,576	16	11,489	976	5,095	.....	6,693	893	3,177	16	4,796	83	1,918
25	Montana	33	3,132	13	1,986	177	956	10	524	164	77	3	1,462	13	879
26	Nebraska	98	4,262	21	2,061	110	2,070	8	78	105	183	13	1,983	5	1,887
27	Nevada	9	327	.....	195	.....	132	.....	.....	.....	.....	.....	195	.....	132
28	New Hampshire	56	3,510	4	1,564	19	1,923	4	32	19	101	.....	1,532	.....	1,822
29	New Jersey	64	21,973	8	8,814	2,644	10,507	8	442	2,295	2,569	.....	8,372	349	7,938
30	New Mexico	15	332	4	162	3	163	.....	59	.....	26	4	103	3	137
31	New York	314	97,529	399	57,028	4,347	35,755	392	42,178	4,238	16,108	7	14,850	109	19,647
32	North Carolina	71	1,936	.....	249	54	1,633	.....	17	54	346	.....	232	.....	1,287
33	North Dakota	29	1,163	.....	621	36	506	.....	530	36	278	.....	91	.....	228
34	Ohio	272	43,849	3,317	15,161	4,625	20,746	2,286	10,001	4,266	5,276	1,031	5,160	359	15,470
35	Oklahoma	72	3,451	12	1,563	44	1,832	2	85	.....	193	10	1,478	44	1,639
36	Oregon	61	3,927	2	1,557	1,597	771	.....	9	1,597	3	2	1,548	.....	768
37	Pennsylvania	327	66,777	4,929	23,681	18,520	19,647	4,801	8,089	18,405	9,343	128	15,592	115	10,304
38	Rhode Island	7	5,970	1	2,631	2,399	939	1	1,807	2,399	164	.....	824	.....	775
39	South Carolina	40	2,521	.....	680	.....	1,841	.....	.....	.....	87	.....	680	.....	1,754
40	South Dakota	37	1,278	15	479	.....	784	.....	126	.....	77	15	353	.....	707
41	Tennessee	78	4,407	10	1,396	54	2,947	.....	26	39	142	10	1,370	15	2,805
42	Texas	218	8,176	44	4,713	639	2,780	35	848	631	234	9	3,865	8	2,546
43	Utah	31	440	.....	349	4	87	.....	.....	.....	.....	.....	349	4	87
44	Vermont	60	1,866	63	461	243	1,099	3	.....	243	64	60	461	.....	1,035
45	Virginia	51	1,415	.....	346	184	885	.....	5	179	322	.....	341	5	563
46	Washington	71	6,771	.....	3,768	.....	3,003	.....	1,592	.....	21	.....	2,176	.....	2,982
47	West Virginia	48	2,885	12	1,017	612	1,244	.....	63	589	178	12	954	23	1,066
48	Wisconsin	206	8,697	405	2,385	490	5,427	394	699	435	1,445	11	1,686	45	3,982
49	Wyoming	18	517	.....	262	72	183	.....	80	72	31	.....	182	.....	152
50	Alaska	9	67	1	63	.....	3	1	11	.....	3	.....	52	.....	.....
51	Hawaii and Porto Rico	6	539	.....	139	131	269	.....	39	131	112	.....	100	.....	157

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

STATIONS—ANALYSIS OF SERVICE, BY STATES AND TERRITORIES: 1907.

INCANDESCENT LIGHTING—NUMBER OF LAMPS WIRED FOR SERVICE.									OTHER VARIETIES OF LAMPS—NERNST, VACUUM, VAPOR, ETC.		STATIONARY MOTORS.		
Aggregate.	Total.		16-candlepower.		32-candlepower.		All other candlepower.						
	Commercial.	Public.	Commercial.	Public.	Commercial.	Public.	Commercial.	Public.	Commercial.	Public.	Number.	Horsepower.	
41,445,997	40,637,304	808,693	35,048,537	592,075	1,293,229	115,381	4,295,538	101,237	156,622	5,716	167,184	1,649,026	1
232,577	230,434	2,143	202,708	1,837	11,945	214	15,781	92	69	.....	541	5,650	2
72,001	71,480	521	59,295	449	4,935	72	7,250	.....	27	.....	339	2,220	3
142,446	140,115	2,331	123,973	702	9,366	1,158	6,776	471	79	.....	198	1,177	4
3,067,383	3,031,750	35,633	2,482,026	28,563	97,146	4,658	452,578	2,412	769	62	11,560	200,067	5
648,446	640,409	8,037	603,804	7,115	15,704	574	20,901	348	768	280	3,232	41,161	6
576,661	569,614	7,047	469,283	2,932	8,373	671	91,958	3,444	9,941	285	2,741	21,146	7
412,948	407,942	5,006	392,253	3,777	10,226	228	5,463	1,001	3,282	.....	1,630	13,053	8
141,258	138,678	2,580	130,120	1,065	6,838	861	1,720	654	26	.....	189	1,584	9
179,913	175,838	4,075	146,039	2,899	15,690	399	14,109	777	424	.....	410	11,078	10
122,460	121,334	1,126	94,428	374	7,953	662	18,953	90	31	.....	406	4,054	11
3,582,178	3,507,351	74,827	2,713,110	59,627	99,415	9,652	694,826	5,548	8,735	396	21,675	137,661	12
1,325,182	1,308,452	16,730	1,171,285	12,930	66,327	2,513	70,840	1,287	3,078	2,400	5,132	33,716	13
808,451	792,996	15,455	670,359	4,616	37,853	8,375	84,784	2,464	839	96	2,643	14,547	14
471,876	468,263	3,613	356,797	2,350	22,878	831	88,588	432	722	153	1,425	12,033	15
483,401	477,244	6,157	393,796	4,330	12,521	1,193	70,927	634	395	.....	1,124	9,962	16
376,990	367,835	9,155	342,300	7,972	6,868	773	18,667	410	235	.....	1,713	16,110	17
442,940	433,982	8,958	359,375	3,779	27,470	2,761	47,137	2,418	252	.....	1,304	19,372	18
634,705	616,105	18,600	611,591	16,492	1,789	1,156	2,725	952	4,844	.....	4,893	19,803	19
2,650,724	2,602,316	48,408	2,479,540	21,460	51,560	5,506	71,216	21,442	4,469	110	15,877	81,246	20
1,711,689	1,661,290	50,399	1,386,798	45,234	59,121	2,867	215,371	2,298	5,293	357	7,089	53,245	21
900,119	882,459	17,660	782,260	11,155	30,088	4,156	70,111	2,349	2,856	48	3,711	41,095	22
141,027	138,972	2,055	119,299	734	9,791	906	9,882	415	52	.....	181	1,520	23
1,698,935	1,689,649	9,286	1,136,748	3,414	42,757	4,013	510,144	1,859	6,457	4	8,923	54,111	24
230,837	229,277	1,560	208,402	1,451	11,280	104	9,595	5	364	.....	971	33,240	25
488,932	482,619	6,313	384,072	4,175	16,288	1,845	82,259	293	1,169	.....	1,719	10,776	26
63,904	63,684	220	60,175	215	1,330	5	2,179	.....	20	15	411	6,856	27
301,300	292,458	8,842	262,183	4,794	6,059	1,925	24,216	2,123	434	.....	1,061	10,231	28
1,673,082	1,648,762	24,320	1,317,787	3,723	201,719	8,135	129,256	12,462	1,927	12	5,994	27,604	29
55,229	54,537	692	37,177	625	6,817	66	10,543	1	150	.....	195	1,231	30
6,991,406	6,753,211	238,195	6,443,667	218,638	59,599	3,620	249,945	15,937	25,438	217	18,051	393,955	31
144,159	141,490	2,669	116,704	1,028	6,445	876	18,341	765	46	51	249	4,345	32
118,875	117,019	1,856	82,934	1,077	10,125	497	23,960	282	358	.....	327	1,816	33
2,254,467	2,207,283	47,184	1,870,192	40,416	63,329	4,361	273,762	2,407	13,166	325	13,083	64,941	34
218,884	216,869	2,015	204,942	1,434	7,616	487	4,311	94	653	.....	1,086	6,586	35
370,092	364,640	5,452	288,853	2,945	37,204	2,201	38,583	306	2,752	.....	2,072	20,452	36
3,861,171	3,815,617	45,554	3,329,414	32,560	83,830	8,265	402,373	4,729	36,248	243	10,063	122,461	37
384,597	375,148	9,449	272,317	3,210	11,862	5,927	90,969	312	632	100	2,082	12,947	38
149,907	147,547	2,360	132,632	1,742	9,971	419	4,944	199	110	1	969	37,388	39
129,486	127,455	2,031	117,622	1,311	3,864	675	5,969	45	157	.....	279	3,649	40
306,818	300,351	6,467	274,254	3,261	6,577	1,542	19,520	1,664	85	.....	1,193	4,524	41
794,972	787,701	7,271	764,091	4,748	10,955	1,367	12,655	1,156	9,183	168	4,223	18,634	42
67,663	64,632	3,031	51,832	873	4,785	1,838	8,015	320	7	.....	406	5,519	43
305,593	293,391	12,202	265,334	2,091	4,284	8,614	23,773	1,497	432	220	776	9,778	44
93,035	91,381	1,654	79,303	567	6,519	846	5,559	241	600	.....	268	3,690	45
618,809	607,594	11,215	381,188	5,171	37,436	2,950	188,970	3,094	5,968	88	1,933	29,686	46
159,800	156,604	3,196	139,498	1,620	7,426	1,162	9,680	414	479	.....	340	4,432	47
779,354	765,063	14,291	686,859	9,909	18,090	3,288	60,114	1,094	2,281	46	2,366	17,995	48
59,315	58,463	852	49,918	685	3,205	167	5,340	.....	320	39	131	685	49
19,818	19,500	318	14,850	216	1,355	98	3,295	4	20	.....	65	587	50
58,492	57,136	1,356	47,457	910	3,083	353	6,595	93	12	.....	162	1,082	51

Digitized by Google

TABLE 121.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—ANALYSIS OF

	STATE OR TERRITORY.	Number of stations.	Aggregate cost.	SUPPLIES AND MATERIALS. Total cost.	Meters.		Motors.		Transformers.		Incandescent lamps.		Nernst lamps, vacuum and vapor lamps, etc. (cost).	Lamp fittings, etc., except for arc lamps (cost).
					Number.	Cost.	Number.	Cost.	Number.	Cost.	Number.	Cost.		
1	United States	4,714	$44,458,568	$21,400,823	31,900	$426,625	4,646	$278,410	6,762	$337,706	19,807,728	$3,118,066	$73,186	$762,593
2	Alabama	55	303,045	87,032	302	3,950	7	570	67	2,911	37,055	6,655	.....	3,855
3	Arizona	15	231,221	52,989	52	882	10	2,809	29	1,950	29,966	5,165	.....	4,386
4	Arkansas	63	228,766	58,799	152	1,884	.....	.....	77	3,271	25,118	4,531	.....	1,868
5	California	129	3,062,669	1,940,030	2,241	43,352	302	48,049	460	25,637	753,301	127,164	62	84,373
6	Colorado	56	822,549	333,516	497	5,935	13	1,025	62	4,046	259,209	44,384	328	20,392
7	Connecticut	41	581,762	247,029	138	2,479	.....	.....	35	2,924	300,789	53,534	819	1,834
8	Delaware[1]	14	351,833	196,534	93	1,149	.....	.....	59	2,345	237,352	41,680	200	471
9	Florida	37	241,360	54,036	44	661	3	419	40	1,719	33,286	6,208	25	7,249
10	Georgia	93	273,398	106,757	72	783	4	216	38	1,319	60,686	10,213	173	5,597
11	Idaho	42	177,086	137,625	249	4,139	24	800	64	6,096	41,415	9,433	175	5,804
12	Illinois	383	3,382,708	1,376,655	2,122	26,403	76	5,798	629	25,112	2,187,088	329,205	875	91,089
13	Indiana	200	1,372,494	509,059	3,627	41,944	64	7,963	567	35,137	397,792	67,239	722	17,529
14	Iowa	192	900,519	367,081	804	11,167	25	1,934	185	7,426	182,685	35,677	554	18,158
15	Kansas	111	477,208	175,798	344	5,862	82	5,318	50	2,200	159,137	27,326	573	18,397
16	Kentucky	83	500,214	201,944	153	2,043	32	2,844	92	3,287	144,517	23,251	93	10,119
17	Louisiana	42	485,772	196,193	68	731	.....	.....	64	1,910	228,314	33,988	129	4,498
18	Maine	81	336,848	220,159	135	1,678	78	15,100	45	3,037	160,178	29,481	714	38,781
19	Maryland	36	547,314	222,156	92	1,653	6	750	101	2,896	416,432	80,298	1,436	3,131
20	Massachusetts	120	2,815,741	1,438,911	4,056	54,890	258	37,485	414	30,812	1,952,204	318,372	2,135	6,451
21	Michigan	234	1,943,393	1,090,659	685	7,371	54	4,552	193	6,865	757,175	142,222	4,517	29,378
22	Minnesota	171	1,121,345	580,410	746	9,527	4	314	141	6,489	415,642	70,304	414	35,073
23	Mississippi	68	214,906	47,173	127	1,688	25	2,062	41	1,456	29,880	5,215	.....	5,041
24	Missouri	162	1,484,961	717,251	900	22,774	35	3,320	270	10,347	447,542	69,524	8,403	23,217
25	Montana	33	423,369	300,818	491	5,552	10	2,193	32	837	101,496	17,633	50	1,497
26	Nebraska	98	476,136	168,144	291	3,983	22	1,387	25	1,772	243,291	41,544	1,552	17,066
27	Nevada	9	66,467	50,600	1	20	6	1,765	30	3,805	10,101	2,258	.....	205
28	New Hampshire	56	255,178	112,927	474	6,682	19	2,349	87	3,508	72,504	14,227	234	4,525
29	New Jersey	64	1,694,281	691,810	4,617	48,307	75	1,427	389	18,726	1,021,106	165,089	419	3,031
30	New Mexico	15	101,197	48,399	6	84	3	375	2	275	7,402	1,252	.....	2,110
31	New York	314	7,030,328	4,028,067	1,012	17,291	2,722	77,609	288	12,805	4,515,759	595,938	16,323	67,156
32	North Carolina	71	197,012	62,948	6	80	.....	.....	16	827	36,968	7,019	55	3,698
33	North Dakota	29	215,590	33,186	173	2,795	8	290	6	303	16,844	2,991	62	797
34	Ohio	272	2,177,633	869,760	1,406	19,054	4	305	424	17,751	764,552	112,971	1,106	25,397
35	Oklahoma	72	360,138	71,885	119	1,487	.....	.....	89	3,703	36,384	6,604	150	884
36	Oregon	61	304,471	130,883	212	3,461	.....	.....	46	3,273	124,998	18,672	3	2,187
37	Pennsylvania	327	4,310,011	2,334,458	1,580	18,225	246	26,670	538	19,941	2,081,458	334,192	13,714	48,526
38	Rhode Island	7	411,028	165,642	244	3,555	7	1,137	70	8,026	229,793	39,439	120	4,221
39	South Carolina	40	198,344	94,301	283	3,479	31	2,910	61	2,207	54,429	9,803	44	12,996
40	South Dakota	37	199,583	58,844	620	6,564	22	1,545	20	4,499	40,622	6,595	51	6,601
41	Tennessee	78	334,236	108,251	146	1,996	10	690	87	3,112	148,624	28,881	.....	8,822
42	Texas	218	1,539,947	361,135	967	11,472	261	10,393	365	12,605	280,546	45,268	11,017	18,190
43	Utah	31	121,590	113,974	67	794	6	607	106	13,402	21,594	4,143	.....	4,436
44	Vermont	60	177,966	118,071	121	2,409	15	1,882	73	4,150	104,822	17,149	1,510	21,906
45	Virginia	51	105,558	54,188	161	1,978	.....	.....	111	3,568	31,679	5,919	52	1,967
46	Washington	71	736,722	575,637	507	6,083	6	370	45	4,399	248,954	36,539	2,284	35,352
47	West Virginia	48	242,563	129,417	15	235	.....	.....	24	1,144	58,877	10,655	.....	1,908
48	Wisconsin	206	819,153	334,964	599	7,155	68	2,998	93	3,430	285,048	49,520	1,461	31,261
49	Wyoming	18	102,955	24,698	83	949	3	180	12	446	13,114	2,096	632	1,163
50	Alaska	9	162,247	47,251	20	260	3	514	24	1,262	20,063	6,040	.....	3,203
51	Hawaii and Porto Rico	6	81,710	22,992	254	3,595	.....	.....	.....	.....	10,697	1,809	.....	455

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

SUPPLIES, MATERIALS, AND FUEL, BY STATES AND TERRITORIES: 1907.

SUPPLIES AND MATERIALS—continued.								COST OF FUEL.						
Carbons, globes, hoods, and other supplies for arc lamps, and repairs (cost).	Poles and other supports (cost).	Wire and cable (cost).	All other supplies and materials, including water for boilers, mill supplies, etc. (cost).	Power purchased.		Rent of water privileges for water wheels or turbines (cost).	Freight not included in cost of materials.	Total.	Coal.	Crude petroleum.	Natural gas.	Manufactured gas.	All other fuel.	
				Electric (cost).	All other (cost).									
$1,698,205	$757,379	$1,769,109	$4,436,728	$6,417,237	$657,235	$386,552	$281,792	$23,057,745	$19,681,212	$2,171,547	$299,648	$194,816	$710,522	1
9,589	5,448	12,424	38,753	.....	.....	900	1,977	216,013	200,915	.....	.....	.....	15,098	2
3,068	2,044	6,359	16,678	7,148	.....	2,500	.....	178,232	6,310	167,922	.....	.....	4,000	3
3,414	4,164	6,385	21,129	2,580	8,870	.....	703	169,967	155,961	.....	.....	.....	14,006	4
80,704	112,749	158,273	518,536	689,170	4,783	46,158	1,020	1,122,639	.....	945,251	.....	150,407	26,981	5
25,303	7,993	27,606	63,590	116,336	.....	11,150	5,428	489,033	486,613	.....	.....	.....	2,420	6
24,306	16,480	25,760	57,109	38,678	5,650	15,518	1,938	334,733	322,601	3,382	.....	.....	8,750	7
13,911	14,703	36,166	11,781	71,969	.....	.....	2,159	155,299	155,299	.....	.....	.....	.....	8
6,728	2,145	5,503	19,094	954	.....	.....	3,325	187,324	97,993	.....	.....	.....	89,331	9
8,252	7,982	13,293	24,466	26,974	.....	4,536	2,953	166,641	118,427	.....	.....	.....	48,214	10
3,774	3,919	6,896	15,546	80,579	.....	89	375	39,461	27,734	.....	.....	.....	11,727	11
183,769	23,907	168,542	209,287	200,057	63,791	27,360	21,460	2,006,053	1,997,418	3,300	1,800	.....	3,535	12
77,777	23,738	79,287	106,935	12,684	14,725	2,765	20,614	863,435	848,624	2,921	10,489	.....	1,401	13
20,223	10,768	33,010	77,700	108,653	19,707	1,980	20,115	533,438	531,169	336	.....	.....	1,933	14
9,403	4,395	9,512	45,269	31,538	10,928	1,200	3,877	301,410	228,761	18,500	52,424	.....	1,725	15
24,428	3,343	19,160	75,638	36,297	.....	.....	1,441	298,270	296,908	.....	.....	.....	1,362	16
15,889	5,654	19,582	37,386	70,427	4,700	1,258	41	289,579	175,060	96,464	714	.....	17,341	17
16,415	4,531	15,972	30,055	32,762	7,006	22,340	2,287	116,689	109,333	555	.....	.....	6,801	18
70,224	2,922	7,753	44,554	6,035	.....	.....	494	325,158	320,263	.....	.....	.....	4,895	19
76,167	61,208	237,745	237,765	282,715	12,727	78,697	1,692	1,376,830	1,344,354	4,364	.....	.....	28,112	20
60,151	15,562	50,730	104,604	613,402	17,130	18,239	15,936	852,734	826,949	.....	.....	212	25,573	21
35,918	44,248	30,472	87,801	177,381	24,126	39,643	18,700	540,935	484,335	.....	.....	12,691	43,909	22
4,644	1,408	3,758	15,242	2,849	3,270	.....	540	167,733	151,801	.....	.....	.....	15,932	23
49,429	37,820	32,994	103,499	336,239	1,620	.....	18,065	767,710	685,117	62,099	15,220	.....	5,274	24
11,312	1,108	13,689	34,865	195,185	11,489	5,250	158	122,551	111,761	.....	.....	.....	10,790	25
10,138	2,632	15,522	53,483	5,579	2,349	5,172	5,965	307,992	301,412	.....	.....	.....	6,580	26
173	8,327	7,075	10,972	15,000	.....	1,000	.....	15,867	8,192	.....	.....	.....	7,675	27
8,627	4,294	10,352	25,922	13,913	6,492	9,580	2,222	142,251	130,328	4,496	.....	.....	7,427	28
96,314	41,256	101,082	167,749	24,417	15,546	2,285	6,162	1,002,471	994,119	1,610	.....	60	6,682	29
808	711	1,378	10,267	28,919	.....	2,220	.....	52,798	51,154	.....	.....	.....	1,644	30
220,505	95,531	189,572	608,975	2,040,875	65,069	12,582	7,836	3,002,261	2,980,946	1,962	7,006	7,648	4,679	31
5,648	1,922	2,726	18,197	12,018	10,152	250	356	134,064	117,374	.....	.....	.....	16,690	32
2,783	1,919	4,961	12,052	.....	.....	.....	4,233	182,404	179,498	.....	.....	.....	2,906	33
102,400	28,623	102,355	412,287	14,645	6,360	3,010	23,496	1,307,873	1,215,778	3,493	83,979	.....	4,623	34
10,016	2,954	3,065	24,813	16,707	1,080	.....	422	288,253	257,777	.....	29,557	.....	919	35
8,794	9,241	16,898	44,720	15,220	1,100	3,835	3,479	173,588	7,470	82,780	.....	.....	83,338	36
258,196	59,839	102,183	647,407	720,039	24,339	25,273	35,914	1,975,553	1,899,829	3,607	67,923	15	4,179	37
24,567	8,918	16,093	42,646	16,122	.....	.....	798	245,386	240,799	4,500	.....	.....	87	38
6,055	6,371	7,911	18,305	24,121	.....	.....	99	104,043	82,420	4,118	.....	.....	17,505	39
2,616	3,822	6,162	8,820	8,215	.....	.....	3,354	140,739	131,277	.....	1,135	.....	8,327	40
18,956	5,181	5,668	26,455	1,495	5,245	400	1,350	225,985	223,879	.....	.....	.....	2,106	41
23,541	18,341	50,332	97,658	27,792	5,241	3,220	26,065	1,178,812	407,216	728,343	.....	.....	43,253	42
1,305	5,219	7,361	26,528	48,916	.....	300	963	7,616	7,606	.....	.....	.....	10	43
5,371	4,142	14,166	14,742	12,785	11,070	5,900	889	59,895	57,884	.....	.....	.....	2,011	44
3,813	1,335	6,679	11,721	10,097	2,400	2,150	2,503	51,370	49,968	.....	.....	.....	1,402	45
18,087	13,357	33,161	50,912	109,252	255,859	9,887	95	161,086	84,968	31,124	.....	.....	44,993	46
11,760	1,767	2,469	24,846	69,266	.....	1,650	3,717	113,146	83,745	.....	29,401	.....	.....	47
21,049	12,038	37,803	69,194	40,014	34,411	18,255	6,395	484,169	405,610	400	.....	23,783	54,376	48
1,875	1,340	3,258	10,766	1,218	.....	.....	175	78,257	78,257	.....	.....	.....	.....	49
506	1,395	4,099	10,863	.....	.....	750	18,359	114,996	13,000	14,770	.....	.....	87,226	50
1,104	1,009	883	3,258	.....	.....	579	10,300	58,718	32,652	26,066	.....	.....	.....	51

Digitized by Google

TABLE 122.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—ANALYSIS OF INCOME, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	INCOME.										
		Gross income.	Electric service.									All other sources
			Total.	Lighting.		Stationary motors.	Electric-railway service.	Current sold to other electric companies.	Electric heating.	Charging automobiles.	All other.	
				Commercial.	Public.							
United States	4,714	$175,642,338	$169,614,691	$100,337,434	$25,417,680	$28,511,550	$7,841,497	$5,519,746	$271,591	$154,747	$1,560,446	$6,027,647
Alabama	55	1,012,743	997,506	687,569	139,525	84,805	60,583	.....	1,215	.....	23,809	15,237
Arizona	15	569,850	544,192	415,860	31,102	71,808	17,818	7,104	.....	.....	500	25,658
Arkansas	63	675,718	664,916	510,286	110,020	18,248	17,075	.....	18	.....	9,269	10,802
California	129	14,416,529	13,922,028	7,220,210	890,802	3,826,462	1,396,735	550,159	16,681	663	20,316	494,501
Colorado	56	3,410,240	3,317,844	1,921,459	259,851	951,836	29,071	154,412	954	78	183	92,396
Connecticut	41	2,469,543	2,452,359	1,465,952	406,981	407,577	46,323	122,973	626	1,279	648	17,184
Delaware[1]	14	1,464,644	1,442,388	992,824	192,219	191,609	31,971	.....	3,627	26,500	3,638	22,256
Florida	37	654,251	630,632	500,650	106,842	16,220	4,383	.....	.....	.....	2,537	23,619
Georgia	93	1,110,510	1,086,601	514,211	217,641	132,964	13,263	204,654	.....	.....	3,868	23,909
Idaho	42	719,395	692,489	486,781	59,528	100,291	12,600	32,504	785	.....	.....	26,906
Illinois	383	15,465,993	14,566,772	8,078,661	2,200,007	2,445,280	1,604,328	148,605	77,407	8,547	3,937	899,221
Indiana	200	4,438,332	4,222,610	2,572,206	885,547	568,199	114,078	41,703	34,346	1,676	4,855	215,722
Iowa	192	2,479,969	2,317,880	1,572,784	442,610	261,202	28,896	577	5,151	2,786	3,874	162,089
Kansas	111	1,514,867	1,419,091	865,072	227,081	224,224	41,679	44,753	3,267	927	12,088	95,776
Kentucky	83	1,660,700	1,610,475	955,555	416,012	220,061	16,627	.....	60	150	2,010	50,225
Louisiana	42	1,852,383	1,829,128	1,242,420	331,459	228,680	7,871	421	336	.....	17,941	23,255
Maine	81	1,453,016	1,324,648	739,226	231,017	284,627	29,454	37,301	3,021	2	.....	128,368
Maryland	36	1,883,084	1,856,359	1,193,476	304,810	349,059	7,114	100	.....	.....	1,800	26,725
Massachusetts	120	10,749,240	10,602,498	6,315,999	2,227,328	1,519,708	288,638	244,054	2,455	1,109	3,207	146,742
Michigan	234	6,072,010	5,750,447	2,958,391	890,406	873,081	277,115	681,638	44,526	794	24,496	321,563
Minnesota	171	3,478,009	3,333,469	2,193,540	507,419	536,622	22,628	41,629	7,942	3,353	20,336	144,540
Mississippi	68	686,700	667,543	501,394	120,565	26,133	.....	2,849	2,782	.....	13,820	19,157
Missouri	162	5,805,828	5,683,795	3,578,819	537,590	985,596	477,784	95,094	.....	3,739	4,573	122,033
Montana	33	2,469,131	2,376,472	1,041,909	108,433	963,669	57,112	188,529	.....	30	16,790	92,659
Nebraska	98	1,562,669	1,474,426	1,019,573	212,838	168,402	18,067	40,584	8,455	2,707	3,800	88,243
Nevada	9	372,108	352,959	184,736	9,789	148,560	8,340	.....	1,444	90	.....	19,149
New Hampshire	56	1,422,345	1,321,296	599,763	225,552	190,764	217,361	73,610	105	86	14,055	101,049
New Jersey	64	5,952,378	5,910,745	3,700,863	1,423,063	682,028	95,991	4,166	2,575	1,173	886	41,633
New Mexico	15	292,682	289,962	208,587	19,564	24,033	5,924	28,919	940	25	1,970	2,720
New York	314	34,859,170	34,067,383	20,430,168	3,866,270	5,688,401	1,168,700	1,579,357	4,210	91,911	1,238,366	791,787
North Carolina	71	543,322	527,672	296,893	128,963	76,431	.....	25,235	70	.....	80	15,650
North Dakota	29	533,383	480,042	366,589	55,122	40,794	10,362	4,000	200	55	2,920	53,341
Ohio	272	7,643,997	7,474,980	4,577,668	1,705,193	1,054,076	47,477	48,476	3,725	290	38,075	169,017
Oklahoma	72	1,106,316	1,097,134	763,024	157,713	103,920	60,977	.....	4,000	1,000	6,500	9,182
Oregon	61	1,965,245	1,840,155	1,093,924	187,025	375,306	167,072	12,446	2,530	.....	1,852	125,090
Pennsylvania	327	16,015,392	15,400,800	8,790,425	3,291,177	2,101,320	901,564	273,315	30,637	3,496	8,866	614,592
Rhode Island	7	1,724,659	1,627,190	833,091	424,430	302,513	62,982	3,000	500	674	.....	97,469
South Carolina	40	901,537	865,708	285,620	124,045	432,384	.....	22,557	907	.....	195	35,829
South Dakota	37	513,682	492,767	310,843	69,120	110,651	1,100	.....	.....	.....	1,053	20,915
Tennessee	78	1,299,983	1,266,610	800,907	262,416	130,798	69,964	1,255	300	.....	970	33,373
Texas	218	3,792,203	3,668,722	2,745,418	321,576	376,897	187,276	.....	2,055	1,529	33,971	123,481
Utah	31	665,241	627,332	222,067	27,405	173,439	.....	203,587	834	.....	.....	37,909
Vermont	60	841,701	795,391	472,908	130,473	162,376	13,281	9,570	162	.....	6,621	46,310
Virginia	51	390,628	380,779	235,937	83,965	40,746	1,825	16,980	115	.....	1,211	9,849
Washington	71	3,410,542	3,219,814	1,838,208	239,948	531,818	143,183	464,797	663	41	1,156	190,728
West Virginia	48	724,253	689,919	425,612	141,415	43,084	4,714	72,434	.....	.....	2,660	34,334
Wisconsin	206	2,278,637	2,127,080	1,350,876	432,481	253,087	52,191	35,799	1,865	37	744	151,557
Wyoming	18	317,580	303,683	258,480	33,342	11,761	.....	.....	100	.....	.....	13,897
Alaska	9	416,103	397,332	276,514	10,833	109,985	.....	.....	.....	.....	.....	18,771
Hawaii and Porto Rico	6	321,592	307,774	219,319	50,136	32,295	.....	1,979	764	175	3,106	13,818

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 123.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER OF SALARIED EMPLOYEES AND TOTAL SALARIES, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	TOTAL.		GENERAL OFFICERS OF CORPORATION.		GENERAL MANAGERS, SUPERINTENDENTS, ETC.		CLERKS AND BOOKKEEPERS.	
		Number.	Salaries.	Number.	Salaries.	Number.	Salaries.	Number.	Salaries.
United States	4,714	12,990	$11,733,787	1,761	$2,202,028	4,357	$5,058,236	6,872	$4,473,523
Alabama	55	109	82,498	11	13,119	53	46,305	45	23,074
Arizona	15	58	55,596	15	13,311	21	29,854	22	12,431
Arkansas	63	75	52,670	7	3,089	42	37,161	26	12,420
California	129	927	1,141,902	72	144,098	222	403,821	633	593,983
Colorado	56	220	220,340	34	50,162	73	95,582	113	74,596
Connecticut	41	170	166,759	54	57,134	44	60,900	72	48,725
Delaware[1]	14	96	84,244	11	23,516	25	24,164	60	36,564
Florida	37	71	47,064	6	2,410	34	27,459	31	17,195
Georgia	93	132	102,862	10	10,690	90	78,013	32	14,159
Idaho	42	72	82,755	11	20,955	29	41,174	32	20,626
Illinois	383	1,034	982,854	109	133,774	293	383,863	632	465,217
Indiana	200	448	310,136	72	65,686	187	154,848	189	89,602
Iowa	192	278	188,899	58	39,741	115	104,785	105	44,373
Kansas	111	182	136,100	23	19,905	93	85,754	66	30,501
Kentucky	83	124	100,691	14	23,356	54	54,030	56	23,305
Louisiana	42	113	97,053	18	24,652	39	39,697	56	32,704
Maine	81	157	98,761	37	23,283	69	52,408	51	23,070
Maryland	36	160	157,825	27	47,122	34	48,473	99	62,230
Massachusetts	120	655	689,496	122	174,925	155	254,250	378	260,321
Michigan	234	554	381,337	47	49,496	229	214,480	278	117,361
Minnesota	171	292	261,578	28	37,613	140	157,483	124	66,482
Mississippi	68	103	71,213	9	9,082	60	48,640	34	13,491
Missouri	162	482	447,578	45	74,144	161	204,767	276	168,667
Montana	33	122	175,087	23	38,385	41	78,019	58	58,683
Nebraska	98	119	104,250	18	20,985	59	61,614	42	21,651
Nevada	9	23	27,071	1	250	12	16,970	10	9,851
New Hampshire	56	109	83,568	38	24,619	34	38,772	37	20,177
New Jersey	64	399	419,954	53	111,866	84	118,289	262	189,799
New Mexico	15	27	21,505	6	2,799	15	14,230	6	4,476
New York	314	1,879	1,775,526	191	336,488	401	593,236	1,287	845,802
North Carolina	71	72	50,937	8	3,520	47	41,917	17	5,500
North Dakota	29	49	43,205	8	5,918	25	27,732	16	9,555
Ohio	272	660	517,401	85	119,074	253	206,709	322	191,618
Oklahoma	72	126	92,329	16	13,656	55	50,363	55	28,310
Oregon	61	118	130,792	7	16,950	46	61,277	65	52,565
Pennsylvania	327	1,189	1,054,939	204	195,516	347	437,924	638	421,499
Rhode Island	7	73	102,077	6	25,601	18	34,745	49	41,731
South Carolina	40	93	67,958	18	15,466	42	39,161	33	13,331
South Dakota	37	56	55,710	9	12,305	35	34,883	12	8,522
Tennessee	78	121	93,558	11	19,240	68	56,514	42	17,804
Texas	218	378	278,797	68	61,184	132	124,942	178	92,671
Utah	31	61	55,356	5	1,230	38	46,123	18	8,003
Vermont	60	109	69,006	19	8,680	47	40,255	43	20,071
Virginia	51	66	38,207	11	5,030	36	26,232	19	6,945
Washington	71	221	247,647	26	45,245	79	103,832	116	98,570
West Virginia	48	83	49,785	24	7,245	39	33,130	20	9,410
Wisconsin	206	290	190,129	55	44,073	128	106,316	107	39,740
Wyoming	18	35	28,722	11	5,440	14	17,140	10	6,142
Alaska	9	27	52,350	5	10,680	16	32,500	6	9,170
Hawaii and Porto Rico	6	30	32,091	5	521	12	20,001	13	11,569

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

25142—10——10

Digitized by Google

TABLE 124.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—AVERAGE NUMBER OF WAGE-EARNERS AND TOTAL WAGES, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	TOTAL.		FOREMEN.		INSPECTORS.		ENGINEERS.		ALL OTHER EMPLOYEES (INCLUDING FIREMEN, DYNAMO AND SWITCHBOARD MEN, LINEMEN, MECHANICS, AND LAMP TRIMMERS).	
		Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
United States	4,714	34,642	$23,686,537	1,434	$1,527,494	894	$697,097	5,857	$4,453,378	26,457	$17,008,568
Alabama	55	234	126,035	9	6,970	4	2,989	62	34,840	159	81,236
Arizona	15	90	75,067	6	6,190	1	900	21	24,573	62	43,404
Arkansas	63	169	105,144	3	2,470	1	480	54	38,849	111	63,345
California	129	2,201	1,952,291	117	157,649	37	39,580	139	149,500	1,908	1,605,562
Colorado	56	698	554,705	41	52,914	6	6,360	88	77,389	563	418,042
Connecticut	41	575	362,893	29	31,112	12	8,876	79	72,511	455	250,394
Delaware[1]	14	258	178,454	7	7,368	9	6,690	31	25,206	211	139,190
Florida	37	194	109,636	4	3,782	6	4,387	47	31,014	137	70,453
Georgia	93	252	129,849	11	10,140	.....	.....	66	38,057	175	81,652
Idaho	42	116	88,370	11	10,530	4	2,500	22	16,526	79	58,814
Illinois	383	2,868	2,049,867	87	84,919	161	104,307	550	427,412	2,070	1,433,229
Indiana	200	1,170	659,127	32	26,214	20	15,248	279	186,620	839	431,045
Iowa	192	577	358,278	26	21,516	4	2,915	231	154,722	316	179,125
Kansas	111	385	238,336	13	11,224	6	4,296	146	99,573	220	123,243
Kentucky	83	461	201,103	13	10,405	2	1,200	108	72,027	338	117,471
Louisiana	42	428	285,929	7	8,400	10	9,240	58	45,772	353	222,517
Maine	81	345	209,245	17	14,561	6	3,857	45	30,421	277	160,406
Maryland	36	510	338,985	23	21,969	19	18,240	62	49,706	406	249,070
Massachusetts	120	2,017	1,546,151	83	87,674	71	60,216	255	248,474	1,608	1,149,787
Michigan	234	1,226	745,476	63	56,634	29	19,991	291	181,283	843	487,568
Minnesota	171	770	494,200	28	21,030	17	15,842	191	140,879	534	316,449
Mississippi	68	185	90,220	7	7,380	.....	.....	69	39,762	109	43,078
Missouri	162	1,318	859,062	55	58,086	53	39,903	180	127,234	1,030	633,839
Montana	33	197	185,681	17	25,740	5	4,390	31	31,657	144	123,894
Nebraska	98	285	209,177	7	6,720	7	5,400	82	58,425	189	138,632
Nevada	9	55	50,193	5	6,750	.....	.....	7	6,055	43	37,388
New Hampshire	56	313	203,181	13	12,186	2	1,560	31	28,327	267	161,108
New Jersey	64	1,360	950,552	30	28,369	33	21,477	153	138,518	1,144	762,188
New Mexico	15	56	45,476	3	3,480	.....	.....	17	17,028	36	24,968
New York	314	5,837	4,044,091	252	306,089	160	132,552	438	376,198	4,987	3,229,252
North Carolina	71	176	80,076	5	3,750	.....	.....	45	24,372	126	51,954
North Dakota	29	101	70,178	4	4,400	1	720	41	32,013	55	33,045
Ohio	272	1,497	1,026,524	55	55,000	54	42,790	405	304,875	983	623,859
Oklahoma	72	288	172,275	13	10,695	2	1,166	107	76,255	166	84,159
Oregon	61	349	285,632	26	27,510	7	6,487	55	49,558	261	202,077
Pennsylvania	327	3,313	2,186,482	134	145,263	93	73,049	498	389,427	2,588	1,578,743
Rhode Island	7	377	248,528	12	13,360	11	9,614	13	13,414	341	212,140
South Carolina	40	168	77,399	11	6,588	3	1,590	35	21,055	119	48,166
South Dakota	37	113	71,433	5	2,576	.....	.....	41	27,371	67	41,486
Tennessee	78	295	154,206	6	4,900	7	5,750	79	49,530	203	94,026
Texas	218	897	510,422	35	30,940	8	5,227	276	177,864	578	296,391
Utah	31	137	104,330	3	2,460	1	960	16	12,178	117	88,732
Vermont	60	188	119,774	17	14,289	5	3,419	28	20,803	138	81,263
Virginia	51	112	60,853	3	1,715	2	1,540	43	26,090	64	31,508
Washington	71	664	552,794	50	62,890	4	4,080	70	65,783	540	420,041
West Virginia	48	179	118,848	7	5,240	.....	.....	64	48,552	108	65,056
Wisconsin	206	577	350,920	26	24,207	11	7,309	190	128,088	350	191,316
Wyoming	18	61	49,089	3	3,240	.....	.....	18	17,592	40	28,257
Alaska	9	49	79,021	4	9,120	1	1,800	16	25,085	28	43,016
Hawaii and Porto Rico	6	80	53,418	3	3,600	4	3,380	6	8,770	67	37,668

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 125.—COMMERCIAL AND MUNICIPAL CENTRAL ELECTRIC STATIONS—ANALYSIS OF MISCELLANEOUS EXPENSES, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	Total expenses.	Rent of stations, line-wire supports, conduits, etc.	Rent of offices.	Taxes.	Injuries and damages.	Insurance.	Ordinary repairs of buildings and machinery.	All other expenses.
United States	4,714	$26,326,257	$2,322,753	$577,193	$6,351,020	$634,991	$1,578,205	$4,300,684	$10,561,411
Alabama	55	138,653	151	8,873	34,704	1,648	14,418	24,852	54,007
Arizona	15	52,463	840	3,185	13,749	1,623	4,022	11,429	17,615
Arkansas	63	57,155	2,060	1,634	7,195	3,050	9,034	16,188	17,994
California	129	2,200,322	2,890	58,477	491,455	26,399	83,735	470,693	1,066,673
Colorado	56	552,541	5,893	25,361	120,656	10,363	38,420	81,399	270,449
Connecticut	41	311,303	719	6,553	44,177	5,528	18,112	80,662	155,552
Delaware[1]	14	260,370	.....	2,910	59,175	6,946	8,196	65,781	117,362
Florida	37	35,170	.....	1,606	6,248	600	8,176	7,934	10,606
Georgia	93	106,866	4,000	4,622	19,038	834	7,266	15,732	55,374
Idaho	42	67,368	5,928	5,536	11,042	588	2,821	6,084	35,369
Illinois	383	1,837,333	48,400	57,079	545,268	87,743	136,228	353,001	609,614
Indiana	200	553,972	1,427	20,994	111,996	11,509	43,506	183,763	180,777
Iowa	192	253,477	909	12,604	49,744	9,529	28,212	52,998	99,481
Kansas	111	179,608	817	8,498	33,150	3,232	15,656	36,126	82,129
Kentucky	83	208,330	630	4,190	81,982	5,994	18,888	41,060	55,586
Louisiana	42	320,972	.....	4,266	105,969	11,745	13,462	35,269	150,261
Maine	81	221,953	104	4,314	46,673	8,318	15,924	29,180	117,440
Maryland	36	473,646	93,317	11,036	73,338	21,153	25,638	53,361	195,803
Massachusetts	120	1,758,405	32,712	26,590	677,385	13,176	146,045	291,739	570,758
Michigan	234	684,009	69,860	13,641	168,044	10,397	33,905	144,758	243,404
Minnesota	171	382,796	2,654	13,592	136,595	11,866	28,953	78,736	110,400
Mississippi	68	64,942	120	1,175	8,941	14,913	9,459	15,509	14,825
Missouri	162	963,146	16,525	22,500	246,371	27,096	57,692	157,553	435,409
Montana	33	318,818	1,354	10,667	78,076	7,109	7,390	20,558	193,664
Nebraska	98	179,150	240	7,265	55,217	2,847	15,417	41,669	56,495
Nevada	9	54,760	12,620	4,130	11,558	56	6,493	6,142	13,761
New Hampshire	56	163,037	309	5,994	39,117	2,505	20,920	34,663	59,529
New Jersey	64	637,277	4,951	21,542	207,413	20,934	47,330	111,566	223,541
New Mexico	15	40,436	.....	1,004	6,682	409	2,356	6,760	23,225
New York	314	6,678,242	1,212,567	75,822	1,580,259	179,944	322,333	807,796	2,499,521
North Carolina	71	42,350	300	1,573	5,665	1,210	5,564	9,587	18,451
North Dakota	29	39,631	492	1,436	9,589	952	3,699	13,163	10,300
Ohio	272	1,615,290	617,723	21,959	276,431	37,548	42,362	204,127	415,140
Oklahoma	72	166,945	1,470	6,429	15,893	2,018	14,301	24,865	101,969
Oregon	61	197,865	120	6,305	62,864	1,007	10,419	50,532	66,618
Pennsylvania	327	2,332,755	142,654	37,910	421,572	29,093	145,751	327,271	1,228,504
Rhode Island	7	229,212	154	5,700	100,028	1,241	27,886	15,455	78,748
South Carolina	40	167,785	17,012	2,411	21,016	713	5,998	21,938	98,697
South Dakota	37	32,360	.....	1,764	6,962	230	3,671	6,324	13,409
Tennessee	78	154,964	1,420	3,683	29,886	3,943	11,223	45,812	58,997
Texas	218	571,722	700	12,308	98,895	31,465	37,253	102,055	289,046
Utah	31	71,832	3,000	3,522	22,780	2,100	276	8,917	31,237
Vermont	60	154,397	2,053	4,635	17,936	33	12,850	35,756	81,134
Virginia	51	33,587	257	3,629	5,708	1,448	4,732	4,066	13,747
Washington	71	374,528	3,701	6,355	108,224	4,836	19,779	65,110	166,523
West Virginia	48	67,815	960	2,253	11,814	4,400	7,979	19,416	20,993
Wisconsin	206	281,692	8,740	7,992	57,168	4,236	31,432	52,611	119,513
Wyoming	18	35,007	.....	1,669	7,372	464	3,023	10,718	11,761
Alaska	9	29,192	.....	480	3,583	.....	720	5,671	18,738
Hawaii and Porto Rico	6	41,182	235	3,300	11,433	.....	1,965	6,866	17,383

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 126.—COMMERCIAL CENTRAL ELECTRIC STATIONS—PRIMARY POWER

	STATE OR TERRITORY.	Number of stations.	PRIMARY POWER.													
			Aggregate.		Steam engines.											
					Total.		500 H. P. and under.		Over 500 H. P. but under 1,000 H. P.		1,000 H. P. but under 2,000 H. P.		2,000 H. P. but under 5,000 H. P.		5,000 H. P. and over.	
			Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.
1	United States	3,462	8,981	3,776,837	5,144	1,546,007	4,535	781,673	342	236,638	178	225,916	70	186,280	19	115,500
2	Alabama	27	67	21,866	45	12,629	38	6,299	4	2,430	3	3,900				
3	Arizona	15	39	7,746	25	4,286	25	4,286								
4	Arkansas	50	82	11,044	71	9,182	71	9,182								
5	California	115	362	379,443	124	94,049	88	19,219	15	10,405	5	6,025	11	23,900	5	34,500
6	Colorado	49	183	81,457	88	31,865	66	10,982	13	9,883	7	7,000	2	4,000		
7	Connecticut	36	163	51,653	86	20,542	83	18,092	3	2,450						
8	Delaware[1]	8	43	32,465	17	7,175	12	2,975	5	4,200						
9	Florida	24	40	6,401	37	6,188	37	6,188								
10	Georgia	34	71	44,740	33	6,345	32	5,095			1	1,250				
11	Idaho	40	54	13,409	18	2,117	18	2,117								
12	Illinois	271	649	268,399	486	117,721	445	66,871	19	13,750	18	23,100	3	9,000	1	5,000
13	Indiana	132	367	96,382	230	50,856	213	37,356	14	9,000	3	4,500				
14	Iowa	141	259	36,928	196	31,168	189	25,613	5	2,857	2	2,698				
15	Kansas	79	172	40,853	103	28,680	95	15,260	4	3,000	1	1,420	3	9,000		
16	Kentucky	69	135	37,400	121	27,955	106	16,355	12	7,800	3	3,800				
17	Louisiana	21	54	19,005	34	16,255	24	4,380	4	2,875	4	5,000	2	4,000		
18	Maine	77	206	55,635	73	15,793	72	15,193	1	600						
19	Maryland	28	95	49,086	68	36,725	58	10,575	4	2,650	1	1,000	4	15,000	1	7,500
20	Massachusetts	96	333	172,530	239	108,445	178	38,339	38	27,456	12	15,400	11	27,250		
21	Michigan	130	404	152,703	141	33,840	129	23,757	9	6,350	3	3,733				
22	Minnesota	79	203	104,500	98	24,730	85	12,380	8	5,200	4	5,150	1	2,000		
23	Mississippi	29	44	7,355	39	6,115	39	6,115								
24	Missouri	104	303	99,370	154	51,367	135	20,577	6	4,030	6	6,630	7	20,130		
25	Montana	31	91	68,467	26	5,455	24	3,455			2	2,000				
26	Nebraska	73	132	25,789	81	12,704	79	10,754	1	750	1	1,200				
27	Nevada	9	19	6,980	3	210	3	210								
28	New Hampshire	52	159	45,869	35	14,560	30	6,860	1	700	3	4,000	1	3,000		
29	New Jersey	57	245	91,905	175	74,563	122	26,735	31	21,050	22	26,778				
30	New Mexico	15	32	4,548	26	4,035	25	3,185	1	850						
31	New York	267	881	709,914	409	197,204	338	62,004	33	23,400	17	22,000	10	29,300	11	60,500
32	North Carolina	35	62	13,908	28	3,907	27	3,307	1	600						
33	North Dakota	21	48	8,852	42	8,395	41	7,745	1	650						
34	Ohio	167	401	149,684	292	99,857	250	42,838	20	12,937	12	16,882	10	27,200		
35	Oklahoma	58	98	20,428	92	19,404	88	15,964	3	1,940	1	1,500				
36	Oregon	50	134	126,211	52	19,730	39	7,530	6	3,800	7	8,400				
37	Pennsylvania	282	865	288,996	589	196,552	513	112,527	43	29,425	29	38,600	3	8,000	1	8,000
38	Rhode Island	6	65	27,886	21	12,380	10	2,920	9	6,460	2	3,000				
39	South Carolina	23	83	81,510	27	5,870	26	3,370					1	2,500		
40	South Dakota	29	59	11,216	30	4,442	30	4,442								
41	Tennessee	50	93	21,910	66	14,570	61	8,570	1	600	3	3,400	1	2,000		
42	Texas	209	401	68,974	274	46,351	256	30,801	14	10,300	4	5,250				
43	Utah	22	44	33,230	8	1,069	8	1,069								
44	Vermont	47	124	33,618	30	7,491	27	5,641	3	1,850						
45	Virginia	37	67	10,760	29	3,462	29	3,462								
46	Washington	65	107	61,815	47	9,149	44	6,499	2	1,350	1	1,300				
47	West Virginia	43	88	19,853	58	12,236	54	9,436	3	1,800	1	1,000				
48	Wisconsin	142	315	49,019	149	24,298	144	21,058	5	3,240						
49	Wyoming	18	40	5,125	29	4,085	29	4,085								
50	Alaska	9	26	4,741	14	2,231	14	2,231								
51	Hawaii and Porto Rico[2]	6	22	4,416	13	3,190	13	3,190								

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

AND GENERATING EQUIPMENT, BY STATES AND TERRITORIES: 1907.

PRIMARY POWER—continued.																		
Steam turbines.												Water wheels.						
Total.		500 H. P. and under.		Over 500 H. P. but under 1,000 H. P.		1,000 H. P. but under 2,000 H. P.		2,000 H. P. but under 5,000 H. P.		5,000 H. P. and over.		Total.		500 H. P. and under.		Over 500 H. P. but under 1,000 H. P.		1,000 H. P. but under 2,000 H. P.		
Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	
348	798,025	49	12,532	118	82,180	61	80,272	76	216,115	44	406,926	2,328	1,318,740	1,761	296,689	243	160,251	160	195,420	1
4	2,392	1	225	3	2,167	.....	.....	.....	.....	.....	.....	13	6,675	9	675	.....	.....	4	6,000	2
5	2,550	3	1,000	2	1,550	.....	.....	.....	.....	.....	.....	4	750	4	750	.....	.....	.....	.....	3
2	1,225	.....	.....	2	1,225	.....	.....	.....	.....	.....	.....	1	300	1	300	.....	.....	.....	.....	4
12	34,250	1	390	1	750	2	2,500	6	16,610	2	14,000	171	208,244	79	17,319	18	14,225	35	41,400	5
13	22,166	1	225	3	2,041	4	5,500	5	14,400	.....	.....	47	25,580	32	5,480	6	3,900	6	6,600	6
12	12,886	3	950	3	2,036	6	9,900	.....	.....	.....	.....	52	17,955	46	7,955	.....	.....	6	10,000	7
8	23,800	2	1,000	1	800	1	1,000	2	6,000	2	15,000	5	285	5	285	.....	.....	.....	.....	8
2	210	2	210	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
1	2,000	.....	.....	.....	.....	.....	.....	1	2,000	.....	.....	35	36,155	13	2,155	4	3,000	11	14,200	10
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	36	11,292	33	8,542	1	750	2	2,000	11
27	138,710	.....	.....	10	6,710	4	5,300	3	10,200	10	116,500	80	10,478	80	10,478	.....	.....	.....	.....	12
22	23,861	3	187	10	7,324	4	4,650	5	11,700	.....	.....	77	19,075	77	19,075	.....	.....	.....	.....	13
2	1,500	.....	.....	2	1,500	.....	.....	.....	.....	.....	.....	41	3,478	41	3,478	.....	.....	.....	.....	14
2	1,500	.....	.....	2	1,500	.....	.....	.....	.....	.....	.....	35	8,461	35	8,461	.....	.....	.....	.....	15
3	9,125	1	125	.....	.....	.....	.....	2	9,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
2	1,825	.....	.....	1	525	1	1,300	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
1	750	.....	.....	1	750	.....	.....	.....	.....	.....	.....	124	38,021	95	13,697	25	19,104	4	5,220	18
7	10,866	2	700	1	666	1	1,500	3	8,000	.....	.....	13	1,347	13	1,347	.....	.....	.....	.....	19
19	46,930	2	550	7	4,930	5	6,700	2	4,750	3	30,000	52	15,596	43	7,377	7	5,519	2	2,700	20
14	36,340	.....	.....	5	3,540	2	3,300	7	29,500	.....	.....	220	81,509	146	21,009	70	38,500	.....	.....	21
7	7,900	3	1,200	.....	.....	2	2,700	2	4,000	.....	.....	61	70,160	47	7,160	2	1,400	5	5,800	22
1	750	.....	.....	1	750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23
10	38,882	.....	.....	2	1,342	.....	.....	4	10,720	4	26,820	5	2,002	2	202	3	1,800	.....	.....	24
3	6,025	.....	.....	1	625	.....	.....	2	5,400	.....	.....	62	56,987	34	6,432	5	4,125	15	17,150	25
4	8,750	.....	.....	1	750	.....	.....	3	8,000	.....	.....	19	2,954	18	2,154	1	800	.....	.....	26
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	6,260	3	310	5	3,750	.....	.....	27
6	4,390	.....	.....	6	4,390	.....	.....	.....	.....	.....	.....	97	24,799	86	13,899	3	2,400	8	8,500	28
10	12,850	.....	.....	2	1,500	7	7,350	1	4,000	.....	.....	21	1,682	21	1,682	.....	.....	.....	.....	29
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	513	6	513	.....	.....	.....	.....	30
45	202,345	5	770	7	4,322	4	5,160	12	30,093	17	162,000	349	303,905	243	42,423	32	20,782	25	31,400	31
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30	9,676	18	2,726	12	6,950	.....	.....	32
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	100	1	100	.....	.....	.....	.....	33
16	42,716	1	50	6	4,500	3	4,166	3	11,500	3	22,500	18	1,682	18	1,682	.....	.....	.....	.....	34
1	750	.....	.....	1	750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35
2	4,000	.....	.....	.....	.....	.....	.....	2	4,000	.....	.....	70	101,877	36	6,111	6	4,266	3	3,000	36
39	49,081	7	1,675	21	14,345	5	6,433	3	6,522	3	20,106	117	30,578	108	22,798	4	2,780	5	5,000	37
6	12,020	.....	.....	.....	.....	2	2,300	4	9,720	.....	.....	16	2,263	16	2,263	.....	.....	.....	.....	38
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	52	75,430	21	8,705	7	4,500	16	20,625	39
5	4,100	3	1,100	.....	.....	2	3,000	.....	.....	.....	.....	12	2,205	10	1,005	2	1,200	.....	.....	40
6	5,360	.....	.....	4	2,680	2	2,680	.....	.....	.....	.....	11	1,060	11	1,060	.....	.....	.....	.....	41
11	15,136	3	1,100	1	536	3	3,500	4	10,000	.....	.....	23	2,762	23	2,762	.....	.....	.....	.....	42
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	36	32,161	19	2,861	6	3,900	8	10,600	43
1	1,333	.....	.....	.....	.....	1	1,333	.....	.....	.....	.....	86	24,484	72	13,234	13	9,050	.....	.....	44
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35	7,098	31	3,273	1	600	3	3,225	45
3	1,160	2	410	1	750	.....	.....	.....	.....	.....	.....	44	51,078	26	5,378	7	4,700	2	2,000	46
5	2,680	2	410	3	2,270	.....	.....	.....	.....	.....	.....	11	3,627	9	1,927	2	1,700	.....	.....	47
8	4,686	1	30	7	4,656	.....	.....	.....	.....	.....	.....	125	17,431	124	16,881	1	550	.....	.....	48
1	225	1	225	.....	.....	.....	.....	.....	.....	.....	.....	6	765	6	765	.....	.....	.....	.....	49
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10	2,490	10	2,490	.....	.....	.....	.....	50
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	1,186	8	1,186	.....	.....	.....	.....	51

[1] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 126.—COMMERCIAL CENTRAL ELECTRIC STATIONS—PRIMARY POWER

	STATE OR TERRITORY.	PRIMARY POWER—continued.								GENERATING AND OTHER MAIN-STATION EQUIPMENT.					
		Water wheels—Continued.				Gas engines.		Auxiliary engines.		Dynamos.					
		2,000 H. P. but under 5,000 H. P.		5,000 H. P. and over.						Aggregate.					
										Total.		Under 200 K. W.		200 K. W. but under 500 K. W.	
		Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.
1	United States	109	326,580	55	339,800	385	49,746	776	64,319	9,778	2,500,209	7,283	513,427	1,375	389,833
2	Alabama					1	20	4	150	68	13,872	45	3,697	15	3,850
3	Arizona					3	70	2	90	53	4,939	44	2,114	7	1,825
4	Arkansas					1	12	7	325	82	7,634	74	4,959	7	2,175
5	California	32	89,600	7	45,700	11	16,585	44	26,315	313	235,612	116	9,194	80	26,205
6	Colorado	3	9,600			4	300	31	1,546	169	52,465	109	6,940	26	7,025
7	Connecticut					1	21	12	249	201	36,653	161	12,363	20	4,900
8	Delaware [1]							13	1,205	65	25,763	40	2,947	14	4,216
9	Florida							1	3	41	4,116	37	3,051	4	1,065
10	Georgia	7	16,800			1	140	1	100	78	28,331	49	3,626	7	1,855
11	Idaho									44	6,922	32	2,472	7	1,950
12	Illinois					8	568	48	922	683	190,295	561	40,245	67	20,850
13	Indiana					11	955	27	1,635	392	66,224	309	22,072	50	13,402
14	Iowa					9	398	11	384	279	25,696	250	15,482	23	6,364
15	Kansas					14	1,301	18	911	174	25,393	141	9,188	20	5,705
16	Kentucky					1	15	10	306	145	26,331	114	7,796	20	5,235
17	Louisiana					3	420	15	505	44	12,270	25	1,870	10	3,200
18	Maine							8	1,071	202	38,428	136	9,058	42	12,250
19	Maryland					3	95	4	53	135	34,911	101	6,411	20	4,600
20	Massachusetts					8	769	15	790	534	126,102	396	28,793	75	22,834
21	Michigan			4	22,000	8	334	21	680	339	82,062	240	15,457	60	17,605
22	Minnesota	4	16,800	3	39,000	16	1,067	21	643	220	67,307	169	10,577	27	7,690
23	Mississippi					1	25	3	465	43	4,620	34	2,420	8	1,700
24	Missouri					12	893	122	6,226	201	60,840	164	10,890	14	3,800
25	Montana	8	29,280							90	39,247	47	3,087	20	5,710
26	Nebraska					11	459	17	922	131	17,030	118	6,850	7	1,750
27	Nevada	1	2,200			6	485	1	25	14	5,690	9	490		
28	New Hampshire					8	1,115	13	1,005	135	31,372	77	6,752	35	8,370
29	New Jersey					9	1,275	30	1,535	333	69,349	213	17,089	81	21,035
30	New Mexico									38	3,789	35	2,764	2	525
31	New York	24	62,800	25	146,500	24	3,085	54	3,375	979	473,664	661	51,342	153	47,061
32	North Carolina							4	325	67	9,062	52	3,387	11	3,175
33	North Dakota					2	205	3	152	49	4,809	44	3,539	5	1,270
34	Ohio					45	4,303	30	1,126	521	105,878	420	29,408	57	16,070
35	Oklahoma					2	200	3	74	105	14,114	78	6,164	24	5,950
36	Oregon	22	73,500	3	15,000	3	100	7	504	102	32,096	48	3,346	35	10,995
37	Pennsylvania					57	6,743	63	6,042	1,167	203,682	916	68,732	154	44,415
38	Rhode Island					4	1,000	18	223	107	20,896	85	5,251	5	1,295
39	South Carolina			8	41,600	1	150	3	60	64	49,295	27	1,895	4	1,100
40	South Dakota					7	296	5	173	55	9,026	47	3,781	3	745
41	Tennessee							10	928	78	15,770	58	4,110	8	2,000
42	Texas					53	3,058	40	1,667	430	46,225	377	21,230	35	9,045
43	Utah	3	14,800							52	32,132	29	1,582	5	1,250
44	Vermont	1	2,200			4	205	3	105	96	19,057	57	4,166	31	8,541
45	Virginia					1	60	2	140	60	7,063	53	3,863	4	950
46	Washington	4	9,000	5	30,000	2	90	11	338	122	62,498	79	6,168	20	5,930
47	West Virginia					9	925	5	385	101	14,009	77	5,964	18	4,845
48	Wisconsin					21	2,004	12	600	337	34,462	291	18,112	33	9,350
49	Wyoming							4	50	40	3,208	38	2,733	2	475
50	Alaska							2	20	25	2,449	22	1,574	3	875
51	Hawaii and Porto Rico [2]							1	40	24	2,562	21	1,662	3	900

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

AND GENERATING EQUIPMENT, BY STATES AND TERRITORIES: 1907—Continued.

GENERATING AND OTHER MAIN-STATION EQUIPMENT—continued.																		
Dynamos—Continued.																		
Aggregate—Continued.								Direct-current, constant-voltage.										
500 K. W. but under 1,000 K. W.		1,000 K. W. but under 2,000 K. W.		2,000 K. W. but under 5,000 K. W.		5,000 K. W. and over.		Total.		Under 200 K. W.		200 K. W. but under 500 K. W.		500 K. W. but under 1,000 K. W.		1,000 K. W. but under 2,000 K. W.		2,000 K. W. but under 5,000 K. W		
Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	
613	383,699	278	346,900	162	436,350	67	430,000	3,169	379,706	2,622	158,311	412	113,955	102	63,890	30	36,550	3	7,000	1
6	4,125	2	2,200	.....	.....	.....	.....	24	4,003	16	1,253	7	1,750	.....	.....	1	1,000	.....	.....	2
2	1,000	.....	.....	.....	.....	.....	.....	27	737	27	737	.....	.....	.....	.....	.....	.....	.....	.....	3
1	500	.....	.....	.....	.....	.....	.....	31	2,145	28	1,345	3	800	.....	.....	.....	.....	.....	.....	4
50	35,213	31	43,000	22	51,500	14	72,500	65	8,900	43	2,075	20	5,105	1	720	1	1,000	.....	.....	5
20	12,550	7	8,700	7	17,250	.....	.....	57	4,852	46	2,102	11	2,750	.....	.....	.....	.....	.....	.....	6
7	3,890	12	13,500	1	2,000	.....	.....	63	6,372	57	5,122	6	1,250	.....	.....	.....	.....	.....	.....	7
6	3,600	1	1,000	2	4,000	2	10,000	26	4,870	15	1,320	10	2,950	1	600	.....	.....	.....	.....	8
.....	.....	.....	.....	.....	.....	.....	.....	4	470	3	170	1	300	.....	.....	.....	.....	.....	.....	9
9	5,750	13	17,400	.....	.....	.....	.....	17	1,271	14	621	3	650	.....	.....	.....	.....	.....	.....	10
5	2,500	.....	.....	.....	.....	.....	.....	9	147	9	147	.....	.....	.....	.....	.....	.....	.....	.....	11
28	16,900	13	14,300	4	11,000	10	87,000	241	32,606	195	11,996	38	13,310	6	3,800	1	1,000	1	2,500	12
20	12,150	12	16,600	1	2,000	.....	.....	105	12,001	87	5,251	14	3,250	3	2,000	1	1,500	.....	.....	13
5	2,850	1	1,000	.....	.....	.....	.....	123	9,142	114	5,592	7	1,750	1	800	1	1,000	.....	.....	14
10	5,500	2	3,000	1	2,000	.....	.....	63	6,121	55	3,161	5	1,460	3	1,500	.....	.....	.....	.....	15
7	4,050	1	1,000	3	8,250	.....	.....	50	5,168	43	2,368	6	2,000	1	800	.....	.....	.....	.....	16
6	4,100	3	3,100	.....	.....	.....	.....	21	4,965	15	1,015	2	800	3	2,100	1	1,050	.....	.....	17
23	16,120	1	1,000	.....	.....	.....	.....	56	5,714	48	2,849	4	865	4	2,000	.....	.....	.....	.....	18
5	3,400	1	1,500	7	14,000	1	5,000	27	2,302	22	1,302	5	1,000	.....	.....	.....	.....	.....	.....	19
40	24,125	19	25,600	1	2,250	3	22,500	157	26,441	126	9,616	17	4,450	10	5,975	4	6,400	.....	.....	20
14	7,500	18	20,500	7	21,000	.....	.....	104	10,180	87	4,205	15	4,475	1	500	1	1,000	.....	.....	21
7	4,540	10	12,000	4	10,000	3	22,500	94	8,267	82	4,242	11	3,025	.....	.....	1	1,000	.....	.....	22
1	500	.....	.....	.....	.....	.....	.....	11	566	11	566	.....	.....	.....	.....	.....	.....	.....	.....	23
9	4,650	3	4,500	7	17,000	4	20,000	81	9,257	70	3,147	3	960	7	3,650	1	1,500	.....	.....	24
15	10,250	.....	.....	8	20,200	.....	.....	24	2,091	21	1,391	3	700	.....	.....	.....	.....	.....	.....	25
2	1,250	2	2,700	2	4,500	.....	.....	57	3,057	54	2,282	3	775	.....	.....	.....	.....	.....	.....	26
4	3,000	.....	.....	1	2,200	.....	.....	3	60	3	60	.....	.....	.....	.....	.....	.....	.....	.....	27
18	10,050	4	4,200	1	2,000	.....	.....	26	3,682	19	1,232	4	950	3	1,500	.....	.....	.....	.....	28
31	21,225	7	7,000	1	3,000	.....	.....	90	21,072	36	2,522	41	9,450	12	8,100	1	1,000	.....	.....	29
1	500	.....	.....	.....	.....	.....	.....	17	925	17	925	.....	.....	.....	.....	.....	.....	.....	.....	30
58	38,611	39	47,800	49	155,350	19	133,500	276	48,151	209	17,381	44	13,050	18	12,720	5	5,000	.....	.....	31
4	2,500	.....	.....	.....	.....	.....	.....	23	1,447	21	1,047	2	400	.....	.....	.....	.....	.....	.....	32
.....	.....	.....	.....	.....	.....	.....	.....	36	3,134	34	2,714	2	420	.....	.....	.....	.....	.....	.....	33
22	13,200	13	16,700	6	15,500	3	15,000	188	31,765	153	9,465	23	8,000	5	3,600	6	8,200	1	2,500	34
2	1,000	1	1,000	.....	.....	.....	.....	29	2,970	24	1,620	5	1,350	.....	.....	.....	.....	.....	.....	35
14	8,255	5	9,500	.....	.....	.....	.....	19	3,756	10	231	7	2,100	2	1,425	.....	.....	.....	.....	36
68	41,635	24	26,900	1	2,000	4	20,000	376	48,125	303	22,310	61	17,165	9	5,150	3	3,500	.....	.....	37
13	7,100	2	3,000	2	4,250	.....	.....	35	8,374	23	2,079	5	1,295	6	3,000	.....	.....	1	2,000	38
16	11,500	9	10,800	8	24,000	.....	.....	2	150	2	150	.....	.....	.....	.....	.....	.....	.....	.....	39
3	1,500	2	3,000	.....	.....	.....	.....	17	1,151	17	1,151	.....	.....	.....	.....	.....	.....	.....	.....	40
8	4,660	3	3,000	1	2,000	.....	.....	17	1,490	14	490	2	500	1	500	.....	.....	.....	.....	41
11	6,950	7	9,000	.....	.....	.....	.....	206	11,977	191	7,252	12	2,775	3	1,950	.....	.....	.....	.....	42
10	6,700	2	2,000	4	9,600	2	11,000	13	522	13	522	.....	.....	.....	.....	.....	.....	.....	.....	43
6	3,350	1	1,000	1	2,000	.....	.....	11	863	9	463	2	400	.....	.....	.....	.....	.....	.....	44
3	2,250	.....	.....	.....	.....	.....	.....	19	1,144	19	1,144	.....	.....	.....	.....	.....	.....	.....	.....	45
4	2,500	7	9,400	10	27,500	2	11,000	30	5,484	24	1,184	2	400	2	1,500	2	2,400	.....	.....	46
6	3,200	.....	.....	.....	.....	.....	.....	31	2,255	30	2,055	1	200	.....	.....	.....	.....	.....	.....	47
13	7,000	.....	.....	.....	.....	.....	.....	150	8,641	145	7,516	5	1,125	.....	.....	.....	.....	.....	.....	48
.....	.....	.....	.....	.....	.....	.....	.....	18	923	18	923	.....	.....	.....	.....	.....	.....	.....	.....	49
.....	.....	.....	.....	.....	.....	.....	.....	10	419	10	419	.....	.....	.....	.....	.....	.....	.....	.....	50
.....	.....	.....	.....	.....	.....	.....	.....	11	797	10	597	1	200	.....	.....	.....	.....	.....	.....	51

[2] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 126.—COMMERCIAL CENTRAL ELECTRIC STATIONS—PRIMARY POWER

	STATE OR TERRITORY.	GENERATING AND OTHER MAIN-STATION EQUIPMENT—continued.											
		Dynamos—Continued.											
		Direct-current, constant-amperage.								Alternating single-phase and polyphase current.			
		Total.		Under 200 K. W.		200 K. W. but under 500 K. W.		500 K. W. but under 1,000 K. W.		1,000 K. W. but under 2,000 K. W.		Total.		Under 200 K. W.	
		Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.
1	United States	1,246	61,753	1,229	53,678	12	3,565	3	2,010	2	2,500	5,363	2,058,750	3,432	301,458
2	Alabama	1	42	1	42							43	9,827	28	2,402
3	Arizona	1	40	1	40							25	4,162	16	1,337
4	Arkansas											51	5,489	46	3,614
5	California	3	124	3	124							245	226,588	70	6,995
6	Colorado	18	1,155	18	1,155							94	46,458	45	3,683
7	Connecticut	50	1,590	50	1,590							88	28,691	54	5,651
8	Delaware[1]	16	712	16	712							23	20,181	9	915
9	Florida	1	29	1	29							36	3,617	33	2,852
10	Georgia	6	183	6	183							55	26,877	29	2,822
11	Idaho											35	6,775	23	2,325
12	Illinois	76	3,469	74	2,969	2	500					366	154,220	292	25,280
13	Indiana	85	3,809	85	3,809							202	50,414	137	13,012
14	Iowa	13	252	13	252							143	16,302	123	9,638
15	Kansas	9	389	9	389							102	18,883	77	5,638
16	Kentucky	6	177	6	177							89	20,986	65	5,251
17	Louisiana											23	7,305	10	855
18	Maine	22	1,179	20	614	2	565					124	31,535	68	5,595
19	Maryland	46	2,064	46	2,064							62	30,545	33	3,045
20	Massachusetts	141	6,789	141	6,789							236	92,872	129	12,388
21	Michigan	40	1,286	40	1,286							195	70,596	113	9,966
22	Minnesota	29	1,097	29	1,097							97	57,943	58	5,238
23	Mississippi											32	4,054	23	1,854
24	Missouri	9	278	9	278							111	51,305	85	7,465
25	Montana	9	244	9	244							57	36,912	17	1,452
26	Nebraska											74	13,973	64	4,568
27	Nevada											11	5,630	6	430
28	New Hampshire	2	100	2	100							107	27,590	56	5,420
29	New Jersey	75	3,870	75	3,870							168	44,407	102	10,697
30	New Mexico											21	2,864	18	1,839
31	New York	133	10,277	127	5,627	2	900	2	1,250	2	2,500	570	415,236	325	28,334
32	North Carolina	1	30	1	30							43	7,585	30	2,310
33	North Dakota	2	50	2	50							11	1,625	8	775
34	Ohio	96	4,252	96	4,252							237	69,861	171	15,691
35	Oklahoma											76	11,144	54	4,544
36	Oregon											83	28,340	38	3,115
37	Pennsylvania	263	14,864	257	12,804	5	1,300	1	760			528	140,693	356	33,618
38	Rhode Island	44	1,763	44	1,763							28	10,759	18	1,409
39	South Carolina											62	49,145	25	1,745
40	South Dakota	1	22	1	22							37	7,853	29	2,668
41	Tennessee	1	50	1	50							60	14,230	43	3,570
42	Texas	1	35	1	35							223	34,213	185	13,943
43	Utah											39	31,610	16	1,060
44	Vermont	9	478	8	178	1	300					76	17,716	40	3,525
45	Virginia	1	25	1	25							40	5,894	33	2,694
46	Washington											92	57,014	55	4,984
47	West Virginia	3	92	3	92							67	11,662	44	3,817
48	Wisconsin	32	857	32	857							155	24,964	114	9,739
49	Wyoming	1	80	1	80							21	2,205	19	1,730
50	Alaska											15	2,030	12	1,155
51	Hawaii and Porto Rico[2]	3	90	3	90							10	1,675	8	975

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

AND GENERATING EQUIPMENT, BY STATES AND TERRITORIES: 1907—Continued.

GENERATING AND OTHER MAIN-STATION EQUIPMENT—continued.																	
Dynamos—Continued.																	
Alternating single-phase and polyphase current—Continued.										Transformers.		Boosters.		Rotaries.		Storage-battery cells in main stations.	Kilowatt capacity of miscellaneous apparatus.	
200 K. W. but under 500 K. W.		500 K. W. but under 1,000 K. W.		1,000 K. W. but under 2,000 K. W.		2,000 K. W. but under 5,000 K. W.		5,000 K. W. and over.										
Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.			
951	272,313	508	317,799	246	307,850	159	429,350	67	430,000	1,432	587,421	106	4,474	175	51,703	9,255	42,256	1
8	2,100	6	4,125	1	1,200					12	3,801			2	600			2
7	1,825	2	1,000							2	266	3	85	2	300		16	3
4	1,375	1	500											2	680		35	4
60	19,100	49	34,493	30	42,000	22	51,500	14	72,500	263	131,354	4	136	6	2,000	118	70	5
15	4,275	20	12,550	7	8,700	7	17,250			73	21,251	7	414	1	350	268	470	6
14	3,650	7	3,890	12	13,500	1	2,000			10	6,885	2	250	1	200			7
1	1,266	5	3,000	1	1,000	2	4,000	2	10,000	3	130	4	266	1	500	204	2,670	8
3	765									4	47							9
4	905	9	5,750	13	17,400					17	15,900							10
7	1,950	5	2,500							20	2,675	1	40				19	11
27	7,040	22	13,100	12	13,300	3	8,500	10	87,000	46	4,167	11	315	13	3,695	1,285	1,898	12
36	10,152	17	10,150	11	15,100	1	2,000			20	1,630			7	2,200		80	13
16	4,614	4	2,050							12	486	1	12	4	866	432	385	14
15	4,245	7	4,000	2	3,000	1	2,000			39	6,446	1	30			280	1,029	15
14	3,235	6	3,250	1	1,000	3	8,250			9	504	4	19				115	16
8	2,400	3	2,000	2	2,050							1	10	3	650			17
36	10,820	19	14,120	1	1,000					23	10,648	1	60					18
15	3,600	5	3,400	1	1,500	7	14,000	1	5,000	4	160	1	2	1	300	168	200	19
58	18,384	30	18,150	15	19,200	1	2,250	3	22,500	46	2,871	4	202	7	2,000	67	860	20
45	13,130	13	7,000	17	19,500	7	21,000			43	20,197	4	127	21	6,100	646	740	21
16	4,665	7	4,540	9	11,000	4	10,000	3	22,500	45	40,096	3	68			248	1,303	22
8	1,700	1	500							3	82	2	15	2	600			23
11	2,840	2	1,000	2	3,000	7	17,000	4	20,000	4	90	2	15			203		24
17	5,010	15	10,250			8	20,200			40	34,175	3	45	1	200		795	25
4	955	2	1,250	2	2,700	2	4,500			4	152	1	2	3	1,300	60		26
		4	3,000			1	2,200			12	4,200	1	8	1	500	64		27
31	7,420	15	8,550	4	4,200	1	2,000			6	300					236	7	28
40	11,585	19	13,125	6	6,000	1	3,000			10	132	7	566	11	3,835	974	584	29
2	525	1	500							3	22						2	30
107	33,111	38	24,641	32	40,300	49	155,350	19	133,500	254	92,324	22	570	27	7,914	1,199	18,988	31
9	2,775	4	2,500							5	1,571							32
3	850													2	108		275	33
34	8,070	17	9,600	7	8,500	5	13,000	3	15,000	22	11,349	1	100	8	2,975	610	3,898	34
19	4,600	2	1,000	1	1,000					8	231	1	7				350	35
28	8,895	12	6,830	5	9,500					41	13,380						625	36
88	25,950	58	35,725	21	23,400	1	2,000	4	20,000	70	21,654	3	238	20	4,470	991	4,354	37
		7	4,100	2	3,000	1	2,250			34	3,225	5	462	5	2,100	548		38
4	1,100	16	11,500	9	10,800	8	24,000			30	29,518						55	39
3	745	3	1,500	2	3,000					5	1,250			1	150	134		40
6	1,500	7	4,160	3	3,000	1	2,000			10	2,570	1	4	7	2,200		885	41
23	6,270	8	5,000	7	9,000					8	429	2	240	7	1,700		535	42
5	1,250	10	6,700	2	2,000	4	9,600	2	11,000	56	35,762							43
28	7,841	6	3,350	1	1,000	1	2,000			30	4,168					189		44
4	950	3	2,250														37	45
18	5,530	2	1,000	5	7,000	10	27,500	2	11,000	61	56,641	2	151	5	1,510	55	208	46
17	4,645	6	3,200							12	1,582						433	47
28	8,225	13	7,000							13	3,100	1	15	4	1,600	276	320	48
2	475																15	49
3	875									6	900							50
2	700													1	250			51

[1] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 127.—COMMERCIAL CENTRAL ELECTRIC STATIONS—SUBSTATION EQUIPMENT, MOTORS, TRANS-

	STATE OR TERRITORY.	Number of stations.	SUBSTATION PLANTS.						
			Total kilowatt capacity.	Transformers.		Rotaries.		Number of cells in storage batteries.	Kilowatt capacity of miscellaneous apparatus.
				Number.	Kilowatts.	Number.	Kilowatts.		
1	United States	3,462	1,499,381	4,047	1,090,261	490	311,003	20,187	98,117
2	Alabama	27	4,500	9	3,400			256	1,100
3	Arizona	15	1,490	9	1,190	2	300		
4	Arkansas	50							
5	California	115	295,933	1,061	283,055	8	2,130	1,156	10,748
6	Colorado	49	19,594	90	18,910	1	400		284
7	Connecticut	36	16,520	44	11,470	11	5,050	1,040	
8	Delaware[1]	8	24,795	21	11,900	18	10,700	1,178	2,195
9	Florida	24							
10	Georgia	34	15,399	35	14,299	4	600		500
11	Idaho	40	4,225	61	3,925				300
12	Illinois	271	89,060	88	17,760	93	69,400	3,018	1,900
13	Indiana	132	23,611	52	19,930	12	1,615	420	2,066
14	Iowa	141	1,443	28	1,411				32
15	Kansas	79	5,850	28	5,850				
16	Kentucky	69	1,200						1,200
17	Louisiana	21	6,117	10	2,117	4	3,000		1,000
18	Maine	77	11,611	55	11,611				
19	Maryland	28	16,525	26	5,725	9	7,400		3,400
20	Massachusetts	96	23,831	154	22,919	3	900	1,388	12
21	Michigan	130	86,693	128	60,008	28	9,290	299	17,395
22	Minnesota	79	53,292	77	44,440	16	5,100	528	3,752
23	Mississippi	29	60	2	60				
24	Missouri	104	35,272	116	6,347	16	7,950	936	20,975
25	Montana	31	17,742	54	16,602	2	600		540
26	Nebraska	73	890	17	840				50
27	Nevada	9	7,700	34	7,700				
28	New Hampshire	52	10,730	57	9,780	3	750	278	200
29	New Jersey	57	9,070	60	4,745	14	4,200		125
30	New Mexico	15							
31	New York	267	487,673	860	316,637	196	161,628	7,761	9,408
32	North Carolina	35	2,070	20	2,070				
33	North Dakota	21							
34	Ohio	167	18,705	59	13,335	4	1,000	470	4,370
35	Oklahoma	58							
36	Oregon	50	40,579	138	29,379	15	10,200		1,000
37	Pennsylvania	282	53,602	183	35,987	23	5,440	1,108	12,175
38	Rhode Island	6	1,823	26	1,823			296	
39	South Carolina	23	47,567	151	47,567				
40	South Dakota	29	1,250	5	1,250				
41	Tennessee	50	249	6	249				
42	Texas	209	1,140						1,140
43	Utah	22	8,540	45	8,540				
44	Vermont	47	8,510	63	8,310	1	200		
45	Virginia	37	2,055	12	2,055				
46	Washington	65	36,107	110	32,957	7	3,150	55	
47	West Virginia	43	1,805	13	1,805				
48	Wisconsin	142	4,503	33	2,253				2,250
49	Wyoming	18	50	1	50				
50	Alaska	9	900	6	900				
51	Hawaii and Porto Rico[2]	6							

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

FORMERS, METERS, CUSTOMERS, AND OUTPUT OF STATIONS, BY STATES AND TERRITORIES: 1907.

STATIONARY MOTORS.		TRANSFORMERS IN CIRCUITS FOR CUSTOMERS.		Number of meters on consumption circuits.	Number of customers furnished electric current.	OUTPUT OF STATIONS, KILOWATT HOURS.		
Number.	Horsepower.	Number.	Kilowatts.			Total for year.	Average per day.	
162,677	1,617,337	255,337	1,897,170	1,468,763	1,663,354	5,572,813,949	15,484,889	1
499	5,412	1,388	6,944	9,256	12,176	27,908,886	77,299	2
339	2,220	605	3,083	5,025	5,854	9,392,302	25,731	3
192	1,167	1,547	6,388	5,549	9,311	9,240,827	25,549	4
11,265	197,861	20,297	208,686	136,933	166,013	657,765,896	1,805,187	5
3,217	41,028	3,795	44,863	40,047	45,519	122,766,944	336,905	6
2,586	20,014	3,472	22,611	17,926	19,147	64,199,442	175,934	7
1,629	13,049	1,482	7,838	11,371	10,094	29,368,587	80,462	8
68	609	1,070	3,769	2,729	4,596	4,358,763	12,107	9
323	10,601	1,231	9,508	3,182	5,599	51,152,893	140,784	10
385	4,002	1,936	10,017	6,710	12,143	9,030,453	26,464	11
21,608	137,405	17,399	91,216	137,336	151,885	439,685,765	1,207,866	12
4,725	30,374	8,636	48,215	52,644	60,866	106,317,599	295,138	13
2,441	13,936	4,052	20,576	30,540	37,347	30,387,174	83,489	14
1,214	10,957	2,215	12,342	16,949	22,839	53,069,247	145,644	15
1,048	9,396	3,620	17,480	15,587	20,820	33,113,858	92,006	16
1,696	16,065	2,783	6,978	12,685	12,244	22,433,161	61,843	17
1,296	19,345	4,622	23,720	15,905	19,279	64,200,146	184,702	18
4,848	19,391	3,652	21,596	20,422	21,462	45,558,955	124,818	19
15,370	76,858	13,983	83,743	78,603	71,727	206,383,440	566,043	20
6,761	51,236	6,174	57,049	54,931	60,096	178,698,930	492,573	21
3,411	39,452	4,368	29,613	29,645	34,303	75,441,141	336,217	22
154	1,213	889	6,162	5,235	7,456	8,558,823	23,338	23
8,837	52,596	7,674	40,153	44,339	50,771	135,838,680	374,769	24
961	33,236	1,695	33,411	14,800	17,265	137,066,091	391,349	25
1,064	10,581	1,884	14,472	18,273	21,837	28,269,376	77,510	26
411	6,850	836	4,319	2,305	3,958	29,621,730	81,820	27
1,061	10,231	3,798	18,098	11,302	13,425	54,453,809	151,353	28
5,974	27,523	13,548	55,616	53,949	55,756	139,357,377	382,572	29
195	1,231	303	1,949	2,701	4,494	4,614,349	12,680	30
17,938	393,004	30,539	489,982	211,062	194,351	1,441,317,340	3,952,327	31
168	3,416	623	3,036	1,533	3,240	8,086,074	22,426	32
312	1,770	232	1,356	5,182	6,460	7,210,255	19,846	33
12,745	63,260	14,714	77,514	73,690	76,122	188,017,835	517,054	34
1,078	6,561	1,965	11,094	13,019	18,505	23,057,560	64,028	35
2,070	20,444	3,314	24,713	20,626	31,735	92,035,297	253,477	36
9,955	121,671	36,125	190,454	136,854	152,921	402,666,869	1,123,143	37
2,080	12,946	2,397	16,304	13,017	11,392	35,505,323	97,275	38
898	36,937	1,597	9,441	4,465	5,403	66,654,585	168,952	39
270	3,610	724	6,516	4,899	6,287	12,584,691	37,377	40
1,175	4,244	2,253	10,347	9,565	11,547	27,493,009	80,945	41
4,133	18,068	8,093	29,662	45,699	65,683	71,215,508	197,948	42
325	4,979	665	6,831	1,601	7,292	57,824,411	158,898	43
710	9,056	2,982	18,239	10,548	12,171	26,160,843	71,840	44
170	2,826	831	6,048	1,861	4,655	7,799,819	22,749	45
1,718	27,952	2,539	52,639	22,407	29,146	250,685,581	688,581	46
338	4,392	1,984	10,092	5,890	9,034	23,157,102	66,902	47
2,285	17,617	4,525	20,586	26,767	34,012	47,588,119	133,899	48
131	685	271	1,901	3,199	5,116	5,499,064	15,060	49
65	587	538	1,614	734	1,879	3,390,401	9,366	50
162	1,082	420	2,002	2,490	5,059	5,049,047	13,833	51

[1] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 128.—COMMERCIAL CENTRAL ELECTRIC STATIONS—

	STATE OR TERRITORY.	Number of stations.	ARC LIGHTING—NUMBER OF LAMPS WIRED FOR SERVICE.											
			Aggregate.	Total.				Direct-current.				Alternating-current.			
				Commercial.		Public.		Commercial.		Public.		Commercial.		Public.	
				Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.
1	United States	3,462	472,773	11,581	244,883	48,875	167,434	9,696	125,150	47,207	54,066	1,885	119,733	1,668	113,368
2	Alabama	27	4,200	262	2,429	24	1,485	.....	1,775	2	85	262	654	22	1,400
3	Arizona	15	754	78	409	27	240	6	106	9	27	72	303	18	213
4	Arkansas	50	1,060	.....	551	.....	509	.....	20	.....	109	.....	531	.....	400
5	California	115	18,826	175	9,199	807	8,645	66	982	634	335	109	8,217	173	8,310
6	Colorado	49	5,266	88	2,179	1,677	1,322	88	75	1,677	67	.....	2,104	.....	1,255
7	Connecticut	36	6,928	241	3,131	1,371	2,185	229	1,766	1,371	474	12	1,365	.....	1,711
8	Delaware[1]	8	4,417	37	2,599	361	1,420	37	1,989	361	1,373	.....	610	.....	47
9	Florida	24	388	.....	78	43	267	.....	12	23	18	.....	66	20	249
10	Georgia	34	1,160	.....	439	172	549	.....	30	103	52	.....	409	69	497
11	Idaho	40	889	.....	359	24	506	.....	.....	5	3	.....	359	19	503
12	Illinois	271	39,032	678	26,258	1,765	10,331	625	14,441	1,757	2,215	53	11,817	8	8,116
13	Indiana	132	16,667	109	7,532	3,284	5,742	63	3,353	3,251	1,630	46	4,179	33	4,112
14	Iowa	141	6,341	72	3,131	939	2,199	70	1,567	898	425	2	1,564	41	1,774
15	Kansas	79	4,180	2	2,311	46	1,821	2	883	46	601	.....	1,428	.....	1,220
16	Kentucky	69	5,578	.....	1,355	36	4,187	.....	136	36	2,404	.....	1,219	.....	1,783
17	Louisiana	21	7,979	.....	4,368	.....	3,611	.....	3,112	.....	106	.....	1,256	.....	3,505
18	Maine	77	2,565	15	1,091	114	1,345	15	290	114	550	.....	801	.....	795
19	Maryland	28	8,577	383	5,381	1,072	1,741	383	3,138	1,072	1,523	.....	2,243	.....	218
20	Massachusetts	96	30,914	155	15,138	2,329	13,292	155	8,663	2,222	6,403	.....	6,475	107	6,889
21	Michigan	130	12,973	83	7,950	833	4,107	72	4,094	719	790	11	3,856	114	3,317
22	Minnesota	79	11,012	7	7,445	1,422	2,138	7	4,969	1,343	401	.....	2,476	79	1,737
23	Mississippi	29	857	14	306	31	506	.....	31	.....	27	14	275	31	479
24	Missouri	104	15,227	16	11,187	264	3,760	.....	6,673	225	2,878	16	4,514	39	882
25	Montana	31	3,043	5	1,965	162	911	2	505	149	32	3	1,460	13	879
26	Nebraska	73	3,320	13	1,898	11	1,398	.....	76	6	58	13	1,822	5	1,340
27	Nevada	9	327	.....	195	.....	132	.....	.....	.....	.....	.....	195	.....	132
28	New Hampshire	52	3,501	4	1,555	19	1,923	4	32	19	101	.....	1,523	.....	1,822
29	New Jersey	57	21,798	8	8,806	2,642	10,342	8	442	2,295	2,569	.....	8,364	347	7,773
30	New Mexico	15	332	4	162	3	163	.....	59	.....	26	4	103	3	137
31	New York	267	94,240	397	56,794	3,849	33,200	392	42,178	3,835	15,308	5	14,616	14	17,892
32	North Carolina	35	417	.....	81	.....	336	.....	5	.....	54	.....	76	.....	282
33	North Dakota	21	907	.....	582	20	305	.....	505	20	116	.....	77	.....	189
34	Ohio	167	34,332	3,264	14,486	3,236	13,346	2,236	9,936	2,949	3,601	1,028	4,550	287	9,745
35	Oklahoma	58	3,130	2	1,503	29	1,596	2	76	.....	144	.....	1,427	29	1,452
36	Oregon	50	3,875	2	1,557	1,597	719	.....	9	1,597	.....	2	1,548	.....	719
37	Pennsylvania	282	62,627	4,929	23,524	17,182	16,992	4,801	8,058	17,067	7,690	128	15,466	115	9,302
38	Rhode Island	6	5,905	1	2,630	2,399	875	1	1,807	2,399	100	.....	823	.....	775
39	South Carolina	23	1,737	.....	634	.....	1,103	.....	.....	.....	87	.....	634	.....	1,016
40	South Dakota	29	967	15	466	.....	486	.....	114	.....	66	15	352	.....	420
41	Tennessee	50	2,679	.....	1,338	9	1,332	.....	14	8	37	.....	1,324	1	1,295
42	Texas	209	7,123	44	4,522	375	2,182	35	838	367	109	9	3,684	8	2,073
43	Utah	22	293	.....	259	.....	34	.....	.....	.....	.....	.....	259	.....	34
44	Vermont	47	1,522	61	447	198	816	3	.....	198	64	58	447	.....	752
45	Virginia	37	721	.....	319	37	365	.....	5	32	110	.....	314	5	255
46	Washington	65	4,550	.....	2,948	.....	1,602	.....	1,592	.....	21	.....	1,356	.....	1,581
47	West Virginia	43	2,157	12	1,017	54	1,074	.....	63	31	48	12	954	23	1,026
48	Wisconsin	142	6,963	405	2,107	340	4,111	394	651	295	1,198	11	1,456	45	2,913
49	Wyoming	18	517	.....	262	72	183	.....	80	72	31	.....	182	.....	152
50	Alaska	9	67	1	63	.....	3	1	11	.....	3	.....	52	.....	.....
51	Hawaii and Porto Rico[2]	6	539	.....	139	131	269	.....	39	131	112	.....	100	.....	157

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

ANALYSIS OF SERVICE, BY STATES AND TERRITORIES: 1907.

INCANDESCENT LIGHTING—NUMBER OF LAMPS WIRED FOR SERVICE.									OTHER VARIETIES OF LAMPS—NERNST, VACUUM, VAPOR, ETC.		STATIONARY MOTORS.		
Aggregate.	Total.		16-candlepower.		32-candlepower.		All other candlepower.						
	Commercial.	Public.	Commercial.	Public.	Commercial.	Public.	Commercial.	Public.	Commercial.	Public.	Number.	Horsepower.	
37,393,549	36,755,093	638,456	31,679,031	474,209	1,156,203	86,212	3,919,859	78,035	148,884	4,584	162,677	1,617,337	1
190,354	189,912	442	163,232	358	11,125	81	15,555	3	67	.....	499	5,412	2
72,001	71,480	521	59,295	449	4,935	72	7,250	.....	27	.....	339	2,220	3
115,134	113,430	1,704	100,538	579	8,016	856	4,876	269	79	.....	192	1,167	4
2,956,174	2,924,367	31,807	2,390,419	26,685	94,032	3,640	439,916	1,482	669	.....	11,265	197,861	5
632,470	624,605	7,865	589,363	7,072	14,771	481	20,471	312	735	280	3,217	41,028	6
523,484	517,038	6,446	416,957	2,932	8,123	270	91,958	3,244	9,926	285	2,586	20,014	7
403,023	398,837	4,186	383,898	3,277	10,226	88	4,713	821	3,252	.....	1,629	13,049	8
53,089	51,982	1,107	47,998	65	3,398	610	586	432	26	.....	68	669	9
65,459	64,224	1,235	55,146	929	6,233	170	2,845	136	421	.....	323	10,601	10
114,386	113,519	867	88,528	209	6,438	582	18,553	76	31	.....	385	4,002	11
3,378,519	3,321,320	57,199	2,555,685	46,619	94,565	6,744	671,070	3,836	8,533	111	21,608	137,405	12
1,027,022	1,015,016	12,006	912,332	9,174	56,780	1,761	45,904	1,071	2,823	2,400	4,725	30,374	13
667,283	656,356	10,927	551,696	3,428	30,660	5,575	74,000	1,924	831	66	2,441	13,936	14
392,456	390,621	1,835	289,519	1,021	17,469	503	83,633	311	687	20	1,214	10,957	15
428,975	424,450	4,525	345,234	3,010	10,628	1,061	68,588	454	245	.....	1,048	9,396	16
332,894	325,642	7,252	302,426	6,867	5,663	229	17,553	156	227	.....	1,696	16,065	17
434,134	427,703	6,431	353,896	1,929	27,170	2,629	46,637	1,873	252	.....	1,296	19,345	18
623,073	608,308	14,765	604,186	12,901	1,739	968	2,383	896	4,824	.....	4,848	19,391	19
2,427,431	2,390,402	37,029	2,273,972	15,644	50,647	3,574	65,783	17,811	4,074	26	15,370	76,858	20
1,293,431	1,275,642	17,789	1,057,735	15,482	48,359	1,071	169,548	1,236	4,210	72	6,761	51,236	21
629,239	617,851	11,388	552,306	7,763	16,639	1,708	48,906	1,917	2,230	48	3,411	39,452	22
53,019	52,347	672	43,480	156	5,137	382	3,730	134	50	.....	154	1,213	23
1,565,757	1,559,916	5,841	1,015,413	2,731	40,148	2,826	504,355	284	6,399	4	8,837	52,596	24
226,073	224,527	1,546	205,002	1,447	11,105	94	8,420	5	324	.....	961	33,236	25
407,705	404,161	3,544	311,787	1,964	12,048	1,480	80,326	100	1,000	.....	1,664	10,581	26
63,904	63,684	220	60,175	215	1,330	5	2,179	.....	20	15	411	6,850	27
287,728	279,359	8,369	254,154	4,794	5,339	1,835	19,866	1,740	434	.....	1,061	10,231	28
1,644,928	1,622,022	22,906	1,291,647	3,323	201,519	7,422	128,856	12,161	1,827	12	5,974	27,523	29
55,229	54,537	692	37,177	625	6,817	66	10,543	1	150	.....	195	1,231	30
6,807,677	6,576,105	231,572	6,329,122	212,893	56,058	3,305	190,925	15,374	25,413	77	17,938	393,004	31
45,456	44,613	843	36,829	46	1,803	538	5,981	259	12	51	168	3,416	32
95,271	93,754	1,517	63,925	892	8,719	423	21,110	202	258	.....	312	1,770	33
1,893,288	1,860,084	33,204	1,562,684	29,027	53,933	2,925	243,467	1,252	12,955	303	12,745	63,260	34
201,271	199,784	1,487	190,597	1,066	5,951	387	3,236	34	648	.....	1,078	6,561	35
359,947	354,864	5,083	281,993	2,822	37,073	2,018	35,798	243	2,752	.....	2,070	20,444	36
3,733,412	3,701,041	32,371	3,226,477	20,752	80,952	6,969	393,612	4,650	36,121	243	9,955	121,671	37
382,589	373,148	9,441	270,317	3,210	11,862	5,927	90,969	304	606	100	2,080	12,946	38
103,283	102,348	935	93,154	681	6,607	194	2,587	60	104	1	898	36,937	39
93,476	92,359	1,117	86,544	611	3,652	464	2,163	42	147	.....	270	3,610	40
253,662	251,355	2,307	229,864	1,308	4,371	565	17,120	434	65	.....	1,175	4,244	41
768,160	763,109	5,051	739,631	3,468	10,823	1,201	12,655	382	9,183	168	4,133	18,068	42
44,993	43,401	1,592	35,506	257	3,173	1,315	4,722	20	.....	.....	325	4,979	43
242,457	231,708	10,749	215,275	1,986	2,406	7,962	13,967	801	195	220	710	9,056	44
62,697	61,556	1,141	50,832	332	5,926	661	4,798	148	600	.....	170	2,826	45
403,567	397,433	6,134	214,199	4,299	28,206	1,512	155,028	323	[a] 2,436	.....	1,718	27,952	46
156,692	153,756	2,936	137,450	1,572	7,363	954	8,943	410	479	.....	338	4,392	47
621,962	612,954	9,008	551,518	6,654	13,001	1,942	48,435	412	2,187	43	2,285	17,617	48
59,315	58,463	852	49,918	685	3,205	167	5,340	.....	320	39	131	685	49
19,818	19,500	318	14,850	216	1,355	98	3,295	4	20	.....	65	587	50
58,492	57,136	1,356	47,457	910	3,083	353	6,596	93	12	.....	162	1,062	51

[a] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 129.—COMMERCIAL CENTRAL ELECTRIC STATIONS—CHARACTER OF OWNERSHIP, SERVICE,

	STATE OR TERRITORY.	NUMBER OF STATIONS.												Stocks and bonds outstanding, par value.	CAPITAL STOCK.		
		Total.	Character of ownership.			Class.		Character of service.							Total.		
								Lighting.							Par value.		
			Individual.	Firm.	Corporation.[1]	Purely electric.	Composite.	Arc.		Incandescent.		Stationary motors.	All other electric service.		Authorized.	Outstanding.	Dividends.
								Commercial.	Public.	Commercial.	Public.						
1	United States	3,462	609	298	2,555	2,127	1,335	1,840	2,206	3,385	2,327	1,659	831	$1,341,995,182	$900,092,160	$741,317,497	$19,300,572
2	Alabama	27	3	1	23	11	16	19	23	27	8	18	7	8,123,250	4,646,400	4,338,150	32,414
3	Arizona	15	.....	1	14	6	9	13	11	14	7	11	5	3,206,700	2,950,000	2,297,800	27,200
4	Arkansas	50	12	7	31	18	32	22	31	50	37	14	17	1,886,600	1,356,200	1,074,600	8,000
5	California	115	21	8	86	61	54	51	57	114	76	81	51	185,875,100	116,616,500	101,279,733	910,114
6	Colorado	49	7	1	41	37	12	33	36	48	31	35	11	26,086,660	14,305,500	13,789,110	151,340
7	Connecticut	36	2	.....	34	21	15	16	21	33	25	26	12	12,924,150	13,615,300	7,908,775	377,304
8	Delaware[2]	8	.....	.....	8	6	2	3	3	8	6	4	3	12,629,450	7,055,000	6,908,850	400,000
9	Florida	24	5	2	17	5	19	8	17	24	18	7	4	1,832,543	1,441,000	1,345,100	.....
10	Georgia	34	4	2	28	18	16	13	25	31	21	16	5	8,891,850	13,330,350	5,362,350	67,427
11	Idaho	40	9	4	27	27	13	22	26	40	24	24	8	7,479,809	6,653,500	6,521,380	40,306
12	Illinois	271	77	38	156	186	85	166	201	271	187	102	45	101,802,550	66,845,600	60,798,750	1,914,106
13	Indiana	132	24	16	92	61	71	81	94	132	59	56	19	28,446,123	16,138,000	13,158,173	158,846
14	Iowa	141	35	14	92	99	42	87	92	141	122	64	45	13,970,500	9,782,250	8,726,500	133,360
15	Kansas	79	12	15	52	41	38	52	59	79	47	39	36	7,877,600	6,192,800	4,984,100	44,025
16	Kentucky	69	11	5	53	43	26	36	52	69	36	20	7	11,061,300	7,002,200	5,315,700	143,965
17	Louisiana	21	3	1	17	12	9	13	14	21	11	13	9	4,377,700	2,043,500	1,814,700	29,300
18	Maine	77	7	4	66	49	28	27	30	72	65	37	16	15,909,655	9,826,040	8,340,655	143,940
19	Maryland	28	4	.....	24	18	10	15	14	28	26	11	2	46,451,773	27,325,283	18,160,273	451,285
20	Massachusetts	96	6	4	86	59	37	58	70	93	83	66	30	47,476,500	46,154,800	43,655,500	3,592,235
21	Michigan	130	31	18	81	76	54	72	97	128	93	52	36	37,396,162	29,050,000	22,100,762	517,396
22	Minnesota	79	15	11	53	39	40	49	66	76	62	43	21	33,428,215	17,499,700	13,782,465	302,491
23	Mississippi	29	4	2	23	16	13	16	17	29	17	11	18	1,179,250	1,345,000	1,064,250	18,003
24	Missouri	104	32	7	65	61	43	47	64	102	72	34	14	53,654,048	36,353,911	22,743,548	963,240
25	Montana	31	2	2	27	19	12	18	17	28	13	18	9	19,822,200	15,206,000	12,618,700	254,350
26	Nebraska	73	28	5	40	54	19	34	48	73	55	22	10	10,417,850	7,900,950	6,599,250	60,093
27	Nevada	9	.....	2	7	4	5	4	5	9	4	4	3	5,113,500	4,450,000	4,333,500	39,000
28	New Hampshire	52	4	3	45	42	10	24	22	50	45	28	15	10,366,900	6,840,000	6,486,400	310,204
29	New Jersey	57	6	1	50	40	17	28	38	57	51	28	21	45,291,240	33,355,800	19,401,990	422,736
30	New Mexico	15	2	.....	13	7	8	10	10	14	8	6	8	1,507,500	1,140,000	752,500	9,000
31	New York	267	37	12	218	189	78	112	141	253	197	138	36	293,037,642	162,591,203	138,957,840	4,041,569
32	North Carolina	35	5	7	23	18	17	8	19	30	23	16	4	1,571,100	2,325,500	1,202,000	17,800
33	North Dakota	21	6	2	13	9	12	17	17	21	15	11	5	2,010,300	1,580,000	1,276,300	49,680
34	Ohio	167	36	16	115	103	64	102	127	167	98	73	49	49,813,950	46,466,600	38,412,350	893,625
35	Oklahoma	58	8	3	47	25	33	46	53	58	36	30	18	8,905,875	6,886,000	4,959,875	45,860
36	Oregon	50	12	7	31	27	23	22	34	49	35	17	18	14,400,300	7,470,500	6,946,800	132,960
37	Pennsylvania	282	22	5	255	243	39	169	171	272	178	180	77	108,323,447	62,045,973	58,472,228	1,534,487
38	Rhode Island	6	.....	.....	6	4	2	5	5	6	6	6	4	7,170,000	9,600,000	5,910,000	312,500
39	South Carolina	23	2	2	19	12	11	12	17	22	16	15	5	13,140,160	13,499,500	10,931,160	13,094
40	South Dakota	29	6	3	20	19	10	15	23	29	22	6	2	4,563,250	3,324,000	3,069,250	3,866
41	Tennessee	50	12	7	31	29	21	18	27	48	32	14	6	6,664,050	3,985,500	3,927,250	1,125
42	Texas	209	42	27	140	86	123	86	67	209	96	86	47	12,932,012	11,545,900	9,027,012	230,191
43	Utah	22	.....	1	21	16	6	8	5	21	5	12	6	4,308,838	3,972,000	2,605,588	38,132
44	Vermont	47	7	4	36	37	10	18	21	45	38	23	11	7,836,725	5,094,000	4,794,225	38,481
45	Virginia	37	9	5	23	26	11	9	19	36	23	16	4	1,393,500	866,500	793,500	7,761
46	Washington	65	3	5	57	38	27	41	46	63	50	37	11	21,108,330	18,698,400	12,760,330	267,293
47	West Virginia	43	3	1	39	25	18	24	33	42	37	15	9	3,549,325	3,899,000	2,495,025	62,160
48	Wisconsin	142	33	17	92	71	71	79	105	135	102	66	31	15,636,925	8,486,000	8,347,425	83,908
49	Wyoming	18	.....	.....	18	14	4	12	16	18	9	8	1	1,142,775	1,344,000	764,775	4,500
50	Alaska	9	.....	.....	9	5	4	8	1	9	7	6	.....	770,800	860,000	705,800	13,500
51	Hawaiiand Porto Rico[3]	6	.....	1	5	2	4	4	6	6	6	4	3	845,940	1,388,100	845,940	71,749

[1] Includes "Other forms of ownership," in order that the operations of individual stations may not be disclosed.
[2] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

CAPITALIZATION, AND COST OF CONSTRUCTION AND EQUIPMENT, BY STATES AND TERRITORIES: 1907.

CAPITAL STOCK—continued.						BONDS.			COST OF CONSTRUCTION AND EQUIPMENT.		
Common.			Preferred.								
Par value.		Dividends.	Par value.		Dividends.	Par value.		Interest.	Total.	During the year.	
Authorized.	Outstanding.		Authorized.	Outstanding.		Authorized.	Outstanding.				
$798,873,386	$666,003,772	$16,883,812	$101,218,774	$75,313,725	$2,416,760	$815,516,672	$600,677,685	$26,842,330	$1,054,034,175	$95,746,208	1
4,096,400	3,788,150	2,414	550,000	550,000	30,000	6,560,000	3,785,100	195,846	6,804,059	408,721	2
2,225,000	1,697,800	7,200	725,000	600,000	20,000	1,527,900	908,900	50,003	1,672,589	180,380	3
1,356,200	1,074,600	8,000	.....	.....	.....	860,000	812,000	37,400	1,505,602	99,945	4
101,016,500	86,422,033	685,438	15,600,000	14,857,700	224,676	108,070,000	84,595,367	4,204,320	110,871,577	8,849,652	5
11,605,500	11,341,610	137,340	2,700,000	2,447,500	14,000	16,865,000	12,297,550	634,009	23,005,536	2,005,800	6
13,400,300	7,693,775	377,304	215,000	215,000	.....	9,415,000	5,015,375	226,364	12,696,303	886,146	7
6,555,000	6,408,850	380,000	500,000	500,000	20,000	8,850,000	5,720,600	224,400	12,626,298	1,162,492	8
1,391,000	1,295,100	.....	50,000	50,000	.....	556,500	487,443	29,706	811,195	56,395	9
11,785,350	4,967,350	64,727	1,545,000	395,000	2,700	13,771,000	3,529,500	183,065	6,226,692	178,335	10
6,653,500	6,521,380	40,306	.....	.....	.....	1,320,729	958,429	56,914	3,203,567	587,200	11
64,295,100	58,298,250	1,808,496	2,550,500	2,500,500	105,610	53,087,000	41,003,800	1,782,357	82,195,708	7,900,051	12
14,773,000	12,433,473	147,174	1,365,000	724,700	11,672	27,409,800	15,287,950	693,939	23,427,532	1,894,947	13
8,479,250	7,639,500	104,860	1,303,000	1,087,000	28,500	6,358,500	5,244,000	265,228	8,953,989	1,175,368	14
6,092,800	4,984,100	44,025	100,000	.....	.....	4,925,000	2,893,500	151,150	5,842,608	566,343	15
7,002,200	5,315,700	143,965	.....	.....	.....	8,385,500	5,745,600	270,335	9,831,444	837,167	16
2,043,500	1,814,700	29,300	.....	.....	.....	2,740,000	2,563,000	83,664	11,137,261	301,804	17
8,264,140	7,063,155	114,838	1,561,900	1,277,500	29,102	9,138,000	7,569,000	311,832	12,443,798	490,082	18
14,358,509	10,000,219	1,200	12,966,774	8,160,054	450,085	40,257,500	28,291,500	1,191,571	21,036,679	2,914,439	19
46,127,300	43,628,000	3,590,428	27,500	27,500	1,807	4,197,500	3,821,000	186,644	40,523,245	4,613,916	20
21,680,000	19,080,012	364,185	7,370,000	3,020,750	153,211	25,836,400	15,295,400	749,258	32,656,235	3,761,219	21
15,299,700	11,644,465	182,491	2,200,000	2,138,000	120,000	28,118,000	19,645,750	672,287	22,192,753	2,632,701	22
1,345,000	1,064,250	18,003	.....	.....	.....	115,000	115,000	6,550	1,321,554	115,698	23
33,303,911	19,693,548	838,240	3,050,000	3,050,000	125,000	32,270,000	30,910,500	1,536,190	32,554,571	2,209,581	24
13,906,000	11,364,700	187,570	1,300,000	1,254,000	66,780	14,845,000	7,203,500	365,233	17,903,167	1,151,941	25
6,898,450	6,114,950	35,928	1,002,500	484,300	24,165	4,649,600	3,818,600	178,608	6,863,096	713,977	26
4,450,000	4,333,500	39,000	.....	.....	.....	780,000	780,000	46,800	4,299,631	107,953	27
6,560,000	6,256,400	301,204	270,000	230,000	9,000	4,157,100	3,880,500	200,250	8,618,803	279,340	28
33,000,800	19,076,990	406,236	355,000	325,000	16,500	27,655,000	25,889,250	890,546	64,961,012	3,834,018	29
1,040,000	752,500	9,000	100,000	.....	.....	1,061,000	755,000	18,323	989,317	93,518	30
146,751,203	126,563,202	3,750,569	15,840,000	12,394,638	291,000	187,266,760	154,079,802	6,399,290	251,199,662	23,403,555	31
2,325,500	1,202,000	17,800	.....	.....	.....	519,100	369,100	18,708	1,425,512	159,795	32
1,480,000	1,176,300	43,680	100,000	100,000	6,000	980,000	734,000	39,000	1,474,985	152,414	33
32,530,600	30,117,750	475,547	13,936,000	8,294,600	418,078	17,258,500	11,401,600	560,674	39,132,506	3,572,162	34
5,916,000	4,391,875	29,420	970,000	568,000	16,440	4,897,000	3,946,000	211,455	6,928,514	565,491	35
6,258,000	5,734,300	72,335	1,212,500	1,212,500	60,625	12,215,000	7,453,500	354,162	14,281,632	1,657,903	36
59,942,873	57,292,078	1,497,191	2,103,100	1,180,150	37,296	80,795,433	49,851,219	2,223,500	72,210,665	6,686,401	37
9,100,000	5,510,000	298,500	500,000	400,000	14,000	1,710,000	1,260,000	61,850	7,295,943	632,307	38
8,074,500	6,999,660	7,844	5,425,000	3,931,500	5,250	3,365,000	2,209,000	106,724	8,390,856	1,612,097	39
2,761,500	2,506,750	3,666	562,500	562,500	200	2,375,000	1,494,000	72,600	2,607,668	170,395	40
3,985,500	3,927,250	1,125	.....	.....	.....	2,816,500	2,736,800	110,454	6,672,899	883,711	41
10,783,400	8,277,012	192,691	762,500	750,000	37,500	4,804,000	3,905,000	190,598	10,905,677	1,616,022	42
3,772,000	2,495,755	36,469	200,000	110,833	1,663	1,930,000	1,702,250	99,482	4,813,440	559,483	43
5,034,000	4,762,225	38,381	60,000	32,000	100	3,911,050	3,042,500	145,760	6,652,907	406,181	44
839,500	786,500	7,201	27,000	7,000	560	690,000	600,000	13,200	1,338,257	157,215	45
17,098,400	11,347,830	192,293	1,600,000	1,412,500	75,000	16,012,000	8,348,000	422,112	18,621,544	2,444,556	46
3,889,000	2,485,025	62,160	10,000	10,000	.....	1,501,300	1,054,300	53,885	2,582,063	362,314	47
8,033,000	7,894,425	83,568	453,000	453,000	240	8,137,000	7,299,500	296,011	9,381,298	629,128	48
1,294,000	764,775	4,500	50,000	.....	.....	551,000	378,000	20,073	942,326	65,949	49
860,000	705,800	13,500	.....	.....	.....	65,000	65,000	3,250	626,837	227,955	50
1,388,100	845,940	71,749	.....	.....	.....	.....	.....	.....	632,936	5,509	51

[a] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 130.—COMMERCIAL CENTRAL ELECTRIC STATIONS—CONDENSED STATEMENT: INCOME AND EXPENSES, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	INCOME.						EXPENSES.			
		Gross income.	Electric service.				All other sources.	Total.	Salaries and wages.	Cost of supplies, materials, and fuel.	Rents, taxes, insurance, and other miscellaneous expenses.
			Total.	Lighting.	Stationary motors.	All other.					
United States	3,462	$161,630,339	$156,000,257	$112,714,851	$27,995,177	$15,290,229	$5,630,082	$97,037,961	$31,935,309	$39,490,881	$25,611,771
Alabama	27	827,167	815,290	648,420	81,513	85,357	11,877	528,317	165,563	230,833	131,921
Arizona	15	569,850	544,192	446,962	71,808	25,422	25,658	414,347	130,663	231,221	52,463
Arkansas	50	553,247	543,086	500,051	17,856	25,179	10,161	355,807	126,464	177,869	51,474
California	115	14,125,542	13,637,803	7,881,923	3,773,587	1,982,293	487,739	8,188,387	3,030,781	2,966,408	2,191,198
Colorado	49	3,358,063	3,266,527	2,131,673	950,156	184,698	91,536	2,118,644	762,665	805,328	550,651
Connecticut	36	2,305,778	2,288,674	1,728,036	389,156	171,482	17,104	1,334,099	496,549	538,214	299,336
Delaware[1]	8	1,422,478	1,400,512	1,144,224	191,584	64,704	21,966	841,098	249,883	335,329	255,886
Florida	24	274,022	260,290	248,828	5,342	6,120	13,732	214,647	78,131	109,560	26,956
Georgia	34	657,015	644,775	295,746	127,744	221,285	12,240	340,430	121,643	127,212	91,575
Idaho	40	687,522	660,616	515,176	99,611	45,829	26,906	397,611	162,911	169,277	65,423
Illinois	271	13,960,932	13,068,516	8,787,325	2,439,673	1,841,518	892,416	7,185,497	2,586,872	2,806,088	1,792,537
Indiana	132	3,580,833	3,384,723	2,658,004	532,260	194,459	196,110	2,311,436	772,042	1,031,592	507,802
Iowa	141	2,063,180	1,937,006	1,648,543	247,639	40,824	126,174	1,398,440	447,894	725,178	225,368
Kansas	79	1,282,639	1,199,163	880,519	216,868	101,776	83,476	873,851	306,631	399,956	167,264
Kentucky	69	1,480,713	1,432,688	1,207,769	206,072	18,847	48,025	905,091	261,964	443,644	199,483
Louisiana	21	1,609,836	1,587,491	1,344,652	226,576	16,263	22,345	1,006,710	328,955	375,274	302,481
Maine	77	1,383,022	1,255,847	901,767	284,302	69,778	127,175	834,066	288,456	329,058	216,552
Maryland	28	1,790,939	1,766,137	1,412,184	344,939	9,014	24,802	1,444,125	468,884	507,409	467,832
Massachusetts	96	9,999,531	9,870,337	7,907,106	1,425,625	537,606	129,194	6,340,137	2,066,254	2,571,926	1,701,957
Michigan	130	4,838,924	4,574,513	2,708,581	842,845	1,023,087	264,411	2,964,020	807,680	1,537,492	618,848
Minnesota	79	2,706,790	2,614,904	2,015,020	506,196	93,688	91,886	1,707,166	575,364	792,642	339,160
Mississippi	29	357,818	348,844	313,791	20,744	14,309	8,974	223,256	80,656	99,228	43,372
Missouri	104	5,301,950	5,189,372	3,642,998	970,985	575,389	112,578	3,411,378	1,190,072	1,294,164	927,142
Montana	31	2,439,922	2,347,563	1,121,493	963,609	262,461	92,359	1,084,484	353,928	413,661	316,895
Nebraska	73	1,344,080	1,259,929	1,025,414	160,902	73,613	84,151	846,697	268,552	406,780	171,365
Nevada	9	372,108	352,959	194,525	148,560	9,874	19,149	198,491	77,264	66,467	54,760
New Hampshire	52	1,400,058	1,299,644	803,663	190,764	305,217	100,414	693,051	281,089	250,362	161,600
New Jersey	57	5,882,309	5,841,072	5,057,810	680,971	102,291	41,237	3,664,476	1,354,660	1,676,232	633,584
New Mexico	15	292,682	289,962	228,151	24,033	37,778	2,720	208,614	66,981	101,197	40,436
New York	267	34,410,708	33,628,543	23,869,100	5,677,498	4,081,945	782,165	19,228,083	5,692,784	6,879,997	6,655,302
North Carolina	35	229,882	219,875	129,843	64,797	25,235	10,007	156,884	58,959	70,290	27,635
North Dakota	21	456,641	410,068	353,139	39,410	17,519	46,573	300,081	90,642	176,438	33,001
Ohio	167	6,508,718	6,368,065	5,199,494	1,034,606	133,965	140,653	4,594,430	1,248,964	1,795,938	1,549,528
Oklahoma	58	1,019,945	1,012,333	837,175	103,140	72,018	7,612	727,276	237,658	327,510	162,108
Oregon	50	1,923,302	1,799,592	1,240,630	375,273	183,689	123,710	890,308	405,421	288,928	195,959
Pennsylvania	282	15,355,241	14,747,144	11,445,777	2,083,559	1,217,808	608,097	9,495,470	3,087,148	4,103,464	2,304,858
Rhode Island	6	1,710,432	1,613,068	1,243,419	302,493	67,156	97,364	982,260	347,947	407,480	226,833
South Carolina	23	754,011	733,041	281,430	428,599	23,012	20,970	394,361	109,305	121,651	163,405
South Dakota	29	439,767	420,785	308,761	109,871	2,153	18,982	301,907	108,603	166,530	26,774
Tennessee	50	1,012,443	991,782	808,961	111,032	71,789	20,661	567,354	180,251	248,663	138,440
Texas	209	3,584,969	3,461,488	2,875,221	362,053	224,214	123,481	2,780,970	746,331	1,475,057	559,582
Utah	22	608,107	570,306	199,145	166,920	204,241	37,801	320,837	140,159	113,586	67,092
Vermont	47	732,283	691,475	508,980	155,160	27,335	40,808	452,250	163,190	150,613	138,447
Virginia	37	253,055	246,161	200,265	26,396	19,500	6,894	161,857	70,393	62,114	29,350
Washington	65	2,874,880	2,691,626	1,573,671	509,774	608,181	183,254	1,642,823	667,978	612,057	362,788
West Virginia	43	669,518	635,224	512,732	42,684	79,808	34,294	432,949	148,083	217,945	66,921
Wisconsin	142	1,899,907	1,773,563	1,434,932	248,231	90,400	126,344	1,357,715	444,231	650,064	263,420
Wyoming	18	317,580	303,683	291,822	11,761	100	13,897	215,773	77,811	102,955	35,007
Alaska	9	416,103	397,332	287,347	109,985	.....	18,771	322,810	131,371	162,247	29,192
Hawaii and Porto Rico[2]	6	321,592	307,774	269,455	32,295	6,024	13,818	208,401	85,509	81,710	41,182

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.
[2] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 131.—COMMERCIAL CENTRAL ELECTRIC STATIONS—ANALYSIS OF INCOME, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	INCOME.										
		Gross income.	Electric service.									All other sources.
			Total.	Lighting.		Stationary motors.	Electric-railway service.	Current sold to other electric companies.	Electric heating.	Charging automobiles.	All other.	
				Commercial.	Public.							
United States	3,462	$161,630,339	$156,000,257	$92,942,447	$19,772,404	$27,995,177	$7,829,275	$5,513,302	$265,241	$153,459	$1,528,952	$5,630,082
Alabama	27	827,167	815,290	558,597	89,823	81,513	60,583	.....	1,075	.....	23,699	11,877
Arizona	15	569,850	544,192	415,860	31,102	71,808	17,818	7,104	.....	.....	500	25,658
Arkansas	50	553,247	543,086	437,605	62,446	17,856	17,075	.....	18	.....	8,086	10,161
California	115	14,125,542	13,637,803	7,064,389	817,534	3,773,587	1,396,735	550,159	15,601	616	19,182	487,739
Colorado	49	3,358,063	3,266,527	1,879,278	252,395	950,156	29,071	154,412	954	78	183	91,536
Connecticut	36	2,305,778	2,288,674	1,362,122	365,914	389,156	46,323	122,973	626	1,204	356	17,104
Delaware[1]	8	1,422,478	1,400,512	965,063	179,161	191,584	30,939	.....	3,627	26,500	3,638	21,966
Florida	24	274,022	260,290	208,011	40,817	5,342	3,583	.....	.....	.....	2,537	13,732
Georgia	34	657,015	644,775	233,862	61,884	127,744	13,263	204,654	.....	.....	3,368	12,240
Idaho	40	687,522	660,616	461,543	53,633	99,611	12,600	32,504	725	.....	.....	26,906
Illinois	271	13,960,932	13,068,516	7,727,753	1,059,572	2,439,673	1,604,328	147,435	77,307	8,547	3,901	892,416
Indiana	132	3,580,833	3,384,723	2,040,524	617,480	532,260	112,578	41,703	34,005	1,393	4,780	196,110
Iowa	141	2,063,180	1,937,006	1,304,038	344,505	247,639	28,896	577	5,131	2,626	3,594	126,174
Kansas	79	1,282,639	1,199,163	736,855	143,664	216,868	41,379	44,753	3,237	921	11,486	83,476
Kentucky	69	1,480,713	1,432,688	868,578	339,191	206,072	16,627	.....	60	150	2,010	48,025
Louisiana	21	1,609,836	1,587,491	1,078,890	265,762	226,576	7,871	421	.....	.....	7,971	22,345
Maine	77	1,383,022	1,255,847	731,822	169,945	284,302	29,454	37,301	3,021	2	.....	127,175
Maryland	28	1,790,939	1,766,137	1,164,953	247,231	344,939	7,114	100	.....	.....	1,800	24,802
Massachusetts	96	9,999,531	9,870,337	5,942,486	1,964,620	1,425,625	288,638	243,946	2,115	796	2,111	129,194
Michigan	130	4,838,924	4,574,513	2,372,164	336,417	842,845	277,115	679,961	44,306	615	21,090	264,411
Minnesota	79	2,706,790	2,614,904	1,674,902	340,118	506,196	22,628	41,629	6,801	3,298	19,332	91,886
Mississippi	29	357,813	348,844	263,281	50,510	20,744	.....	2,849	2,734	.....	8,726	8,974
Missouri	104	5,301,950	5,189,372	3,290,339	352,659	970,985	471,694	95,694	.....	3,739	4,262	112,578
Montana	31	2,439,922	2,347,563	1,019,608	101,885	963,609	57,112	188,529	.....	30	16,790	92,359
Nebraska	73	1,344,080	1,259,929	887,429	137,985	160,902	18,067	40,584	8,455	2,707	3,800	84,151
Nevada	9	372,108	352,959	184,736	9,789	148,560	8,340	.....	1,444	90	.....	19,149
New Hampshire	52	1,400,058	1,299,644	584,595	219,068	190,764	217,361	73,610	105	86	14,055	100,414
New Jersey	57	5,882,309	5,841,072	3,660,638	1,397,172	680,971	93,491	4,166	2,575	1,173	886	41,237
New Mexico	15	292,682	289,962	208,587	19,564	24,033	5,924	28,919	940	25	1,970	2,720
New York	267	34,410,708	33,628,543	20,204,998	3,664,102	5,677,498	1,168,700	1,579,357	4,153	91,819	1,237,916	782,165
North Carolina	35	229,882	219,875	95,230	34,613	64,797	.....	25,235	.....	.....	.....	10,007
North Dakota	21	456,641	410,068	315,929	37,210	39,410	10,362	4,000	200	37	2,920	46,573
Ohio	167	6,508,718	6,368,065	4,025,919	1,173,575	1,034,606	47,477	48,476	2,350	290	35,372	140,653
Oklahoma	58	1,019,945	1,012,333	706,374	130,801	103,140	60,977	.....	4,000	1,000	6,041	7,612
Oregon	50	1,923,302	1,799,592	1,061,886	178,744	375,273	167,072	12,446	2,394	.....	1,787	123,710
Pennsylvania	282	15,355,241	14,747,144	8,568,268	2,857,509	2,083,559	901,564	273,315	30,627	3,436	8,866	608,097
Rhode Island	6	1,710,432	1,613,068	828,189	415,230	302,493	62,982	3,000	500	674	.....	97,364
South Carolina	23	754,011	733,041	207,713	73,717	428,599	.....	22,557	260	.....	195	20,970
South Dakota	29	439,767	420,785	263,132	45,629	109,871	1,100	.....	.....	.....	1,053	18,982
Tennessee	50	1,012,443	991,782	690,963	117,998	111,032	69,964	555	300	.....	970	20,661
Texas	209	3,584,909	3,461,488	2,633,728	241,493	362,053	187,276	.....	2,055	1,529	33,354	123,481
Utah	22	608,107	570,306	181,408	17,737	166,920	.....	203,407	834	.....	.....	37,801
Vermont	47	732,283	691,475	408,813	100,167	155,160	13,281	8,620	162	.....	5,272	40,808
Virginia	37	253,055	246,161	166,121	34,144	26,396	1,825	16,980	15	.....	680	6,894
Washington	65	2,874,880	2,691,626	1,446,819	126,852	509,774	143,183	463,138	663	41	1,156	183,254
West Virginia	43	669,518	635,224	418,774	93,958	42,684	4,714	72,434	.....	.....	2,660	34,294
Wisconsin	142	1,899,907	1,773,563	1,111,195	323,737	248,231	52,191	35,799	1,776	37	597	126,344
Wyoming	18	317,580	303,683	258,480	33,342	11,761	.....	.....	100	.....	.....	13,897
Alaska	9	416,103	397,332	276,514	10,833	109,985	.....	.....	.....	.....	.....	18,771
Hawaii and Porto Rico[2]	6	321,592	307,774	219,319	50,136	32,295	.....	1,979	764	175	3,106	13,818

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.
[2] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 132.—COMMERCIAL CENTRAL ELECTRIC STATIONS—ANALYSIS OF

	STATE OR TERRITORY.	Number of stations.	Aggregate cost.	SUPPLIES AND MATERIALS.									
				Total cost.	Meters.		Motors.		Transformers.		Incandescent lamps.		Nernst lamps, vacuum and vapor lamps, etc. (cost).	Lamp fittings, etc., except for arc lamps (cost).
					Number.	Cost.	Number.	Cost.	Number.	Cost.	Number.	Cost.		
1	United States	3,462	$39,490,881	$19,665,919	28,024	$378,432	4,522	$270,661	5,468	$288,586	19,036,085	$2,973,508	$69,230	$676,339
2	Alabama	27	230,833	72,709	262	3,518	4	250	30	1,160	29,796	5,381	.....	3,352
3	Arizona	15	231,221	52,989	52	882	10	2,809	29	1,950	29,966	5,165	.....	4,386
4	Arkansas	50	177,869	46,717	132	1,622	.....	.....	65	2,778	16,269	2,957	.....	1,783
5	California	115	2,966,408	1,884,052	2,234	43,264	302	48,049	458	25,498	740,765	125,091	62	82,395
6	Colorado	49	805,328	324,559	497	5,935	13	1,025	62	4,046	255,714	43,691	328	20,219
7	Connecticut	36	538,214	238,619	137	2,467	.....	.....	33	2,889	288,615	51,416	819	1,834
8	Delaware[1]	8	335,329	191,452	93	1,149	.....	.....	59	2,345	233,562	40,982	200	453
9	Florida	24	109,560	29,643	36	564	3	419	38	1,605	26,785	4,994	25	5,226
10	Georgia	34	127,212	61,418	68	735	4	216	10	422	30,850	5,096	.....	2,020
11	Idaho	40	169,277	133,630	231	3,930	24	800	61	5,664	41,315	9,413	175	5,779
12	Illinois	271	2,806,088	1,166,610	1,986	24,906	76	5,798	529	21,542	2,155,847	322,401	725	89,513
13	Indiana	132	1,031,592	392,107	3,031	35,262	61	7,645	354	28,886	362,600	60,786	492	15,317
14	Iowa	141	725,178	304,085	570	8,099	22	1,754	155	6,225	145,185	27,858	419	14,053
15	Kansas	79	399,956	148,596	284	5,120	82	5,318	34	1,461	131,285	22,289	557	12,886
16	Kentucky	69	443,644	177,394	133	1,736	32	2,844	73	2,774	126,407	19,743	93	8,555
17	Louisiana	21	375,274	177,884	23	336	.....	.....	23	540	220,690	32,171	129	4,098
18	Maine	77	329,058	212,970	135	1,678	78	15,100	45	3,037	157,214	28,954	714	37,871
19	Maryland	28	507,409	214,124	92	1,653	6	750	99	2,840	406,652	78,945	1,436	3,051
20	Massachusetts	96	2,571,926	1,318,930	3,972	53,738	256	37,451	394	29 245	1,892,107	306,452	2,135	4,658
21	Michigan	130	1,537,492	963,057	419	4,529	48	4,049	134	4,488	665,775	125,206	4,377	18,428
22	Minnesota	79	792,642	489,237	514	6,605	3	229	87	5,066	373,762	62,249	326	30,295
23	Mississippi	29	99,228	22,389	44	579	.....	.....	23	931	23,715	4,051	.....	1,268
24	Missouri	104	1,294,164	668,214	698	18,400	35	3,320	157	6,121	421,447	64,770	7,652	19,486
25	Montana	31	413,661	297,758	491	5,552	10	2,193	18	537	97,996	16,927	50	1,306
26	Nebraska	73	406,780	153,037	264	3,596	22	1,387	14	1,215	215,318	36,320	1,552	15,415
27	Nevada	9	66,467	50,600	1	20	6	1,765	30	3,805	10,101	2,258	.....	205
28	New Hampshire	52	250,362	108,559	474	6,682	19	2,349	86	3,481	69,150	13,253	234	4,525
29	New Jersey	57	1,676,232	687,084	4,560	47,636	72	1,217	375	18,282	1,019,660	164,659	405	2,976
30	New Mexico	15	101,197	48,399	6	84	3	375	2	275	7,402	1,252	.....	2,110
31	New York	267	6,879,997	3,975,968	986	16,994	2,722	77,609	269	12,093	4,495,742	592,143	16,174	64,515
32	North Carolina	35	70,290	23,033	2	34	.....	.....	6	450	12,480	2,484	55	2,924
33	North Dakota	21	176,438	23,399	80	1,158	6	275	6	303	13,959	2,423	62	694
34	Ohio	167	1,795,938	748,677	749	11,129	4	305	255	9,466	707,661	102,708	877	20,647
35	Oklahoma	58	327,510	66,944	113	1,414	.....	.....	64	2,815	35,694	6,488	150	884
36	Oregon	50	288,928	124,903	212	3,461	.....	.....	42	3,093	122,398	18,209	3	2,056
37	Pennsylvania	282	4,103,464	2,249,871	1,409	16,287	244	26,512	498	18,159	2,047,319	328,571	13,689	45,014
38	Rhode Island	6	407,480	163,915	232	3,393	7	1,137	69	7,951	229,293	39,339	120	4,221
39	South Carolina	23	121,651	68,491	145	1,843	7	600	59	2,131	45,358	8,124	.....	5,970
40	South Dakota	29	166,530	44,921	610	6,414	22	1,545	20	4,499	37,532	6,053	6	5,947
41	Tennessee	50	248,663	82,896	130	1,804	1	90	59	2,142	129,105	25,380	.....	5,873
42	Texas	209	1,475,057	350,807	965	11,447	261	10,393	356	12,389	273,378	44,000	11,017	17,890
43	Utah	22	113,586	108,163	55	629	6	607	85	12,275	14,659	2,786	.....	4,233
44	Vermont	47	150,613	102,603	119	2,367	15	1,882	55	3,421	99,297	15,882	1,050	19,928
45	Virginia	37	62,114	31,964	37	482	.....	.....	19	962	22,499	4,047	52	1,862
46	Washington	65	612,057	454,172	207	2,933	1	70	45	4,399	235,024	34,386	1,096	30,666
47	West Virginia	43	217,945	115,013	15	235	.....	.....	23	1,114	58,567	10,584	.....	1,898
48	Wisconsin	142	650,064	268,659	436	5,182	32	2,344	49	1,370	247,056	42,475	1,342	26,491
49	Wyoming	18	102,955	24,698	83	949	3	180	12	446	13,114	2,696	632	1,163
50	Alaska	9	162,247	47,251	20	260	3	514	24	1,262	20,063	6,040	.....	3,203
51	Hawaii and Porto Rico[2]	6	81,710	22,992	254	3,595	.....	.....	.....	.....	10,697	1,809	.....	455

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.

Digitized by Google

SUPPLIES, MATERIALS, AND FUEL, BY STATES AND TERRITORIES: 1907.

SUPPLIES AND MATERIALS—continued.								COST OF FUEL.						
Carbons, globes, hoods, and other supplies for arc lamps, and repairs (cost).	Poles and other supports (cost).	Wire and cable (cost).	All other supplies and materials, including water for boilers, mill supplies, etc. (cost).	Power purchased.		Rent of water privileges for water wheels or turbines (cost).	Freight, not included in cost of materials.	Total.	Coal.	Crude petroleum.	Natural gas.	Manufactured gas.	All other fuel.	
				Electric (cost).	All other (cost).									
$1,456,927	$701,081	$1,623,078	$3,993,181	$6,080,905	$615,283	$351,443	$187,265	$19,824,962	$16,780,874	$2,043,000	$259,181	$194,816	$547,091	1
8,047	3,961	10,896	33,867	.....	.....	900	1,377	158,124	151,427	.....	.....	.....	6,697	2
3,068	2,044	6,359	16,678	7,148	.....	2,500	.....	178,232	6,310	167,922	.....	.....	4,000	3
1,797	2,797	4,970	18,260	2,580	6,870	.....	303	131,152	119,251	.....	.....	.....	11,901	4
77,164	111,428	153,588	514,022	651,530	4,783	46,158	1,020	1,082,356	.....	911,568	.....	150,407	20,381	5
25,028	7,916	27,522	62,637	109,634	.....	11,150	5,428	480,769	478,349	.....	.....	.....	2,420	6
22,671	15,485	25,067	54,187	38,678	5,650	15,518	1,938	299,595	295,498	.....	.....	.....	4,097	7
13,574	14,658	36,141	10,494	71,391	.....	.....	65	143,877	143,877	.....	.....	.....	.....	8
1,622	1,002	3,388	6,652	954	.....	.....	3,192	79,917	12,048	.....	.....	.....	67,869	9
3,403	5,180	8,302	13,844	17,664	.....	4,536	.....	65,794	42,344	.....	.....	.....	23,450	10
3,680	3,709	6,789	15,148	78,079	.....	89	375	35,647	23,920	.....	.....	.....	11,727	11
125,007	18,533	157,327	153,824	146,478	59,691	27,360	13,505	1,639,478	1,637,373	1,500	.....	.....	605	12
61,303	20,797	69,070	80,868	1,440	3,125	2,690	4,426	639,485	627,357	2,921	7,850	.....	1,357	13
17,369	8,410	24,053	56,882	108,653	17,767	1,980	10,563	421,093	418,984	336	.....	.....	1,773	14
7,141	4,048	8,276	37,730	31,538	9,219	300	2,713	251,360	186,796	18,500	44,839	.....	1,225	15
19,151	3,003	18,226	64,360	36,297	.....	.....	612	266,250	264,888	.....	.....	.....	1,362	16
14,413	5,270	18,062	27,464	70,427	3,716	1,258	.....	197,390	138,810	43,895	714	.....	13,971	17
12,224	4,231	15,921	29,148	32,762	7,006	22,340	1,984	116,088	108,732	555	.....	.....	6,801	18
67,897	2,812	7,493	40,968	6,035	.....	.....	244	293,285	289,751	.....	.....	.....	3,534	19
70,569	56,678	221,682	219,261	243,546	12,727	59,153	1,635	1,252,996	1,226,917	2,301	.....	.....	23,778	20
30,755	8,408	39,064	71,733	606,345	14,330	17,614	13,731	574,435	556,846	.....	.....	212	17,377	21
29,677	41,760	22,046	56,602	170,606	24,126	36,043	3,607	303,405	269,295	.....	.....	12,691	21,419	22
2,439	582	1,990	7,264	.....	3,270	.....	15	76,839	64,198	.....	.....	.....	12,641	23
43,114	36,125	27,546	90,175	336,239	1,620	.....	13,646	625,950	552,078	59,392	11,086	.....	3,394	24
11,121	1,063	13,552	33,375	195,185	11,489	5,250	158	115,903	105,113	.....	.....	.....	10,790	25
8,385	2,200	14,456	50,409	5,579	2,349	5,172	5,002	253,743	247,492	.....	.....	.....	6,251	26
173	8,327	7,075	10,972	15,000	.....	1,000	.....	15,867	8,192	.....	.....	.....	7,675	27
8,627	4,276	10,187	25,538	12,613	4,992	9,580	2,222	141,803	129,902	4,496	.....	.....	7,405	28
95,960	40,921	100,732	165,886	24,417	15,546	2,285	6,162	989,148	980,868	1,610	.....	60	6,610	29
808	711	1,378	10,267	28,919	.....	2,220	.....	52,798	51,154	.....	.....	.....	1,644	30
213,944	94,608	185,260	597,282	2,024,008	65,069	12,581	3,688	2,904,029	2,896,567	.....	6,732	7,648	3,082	31
1,591	1,187	1,958	8,715	2,330	950	250	105	47,257	40,114	.....	.....	.....	7,143	32
2,217	1,346	4,021	8,427	.....	.....	.....	2,473	153,039	151,944	.....	.....	.....	1,095	33
81,482	25,231	92,074	372,236	12,446	6,360	1,295	12,421	1,047,261	973,140	50	69,451	.....	4,620	34
9,279	2,446	2,906	22,353	16,707	1,080	.....	422	260,566	232,190	.....	27,457	.....	919	35
8,573	8,940	16,350	44,064	11,920	1,100	3,655	3,479	164,025	6,060	82,780	.....	.....	75,185	36
241,304	57,783	97,783	618,889	708,143	22,603	22,514	32,620	1,853,593	1,787,007	1,302	64,171	15	1,098	37
24,481	8,488	16,073	42,246	16,122	.....	.....	344	243,5 5	239,065	4,500	.....	.....	.....	38
3,953	5,454	5,037	15,359	19,921	.....	.....	99	53,1 0	35,657	4,118	.....	.....	13,385	39
1,856	3,126	5,543	6,578	.....	.....	.....	3,354	121,(09	113,622	.....	.....	.....	7,987	40
14,166	4,336	4,237	20,405	240	3,165	400	658	165,767	164,141	.....	.....	.....	1,626	41
21,553	17,193	48,331	94,276	27,792	5,241	3,220	26,065	1,124,250	378,867	704,130	.....	.....	41,253	42
1,015	4,542	6,101	25,883	48,916	.....	300	876	5,423	5,413	.....	.....	.....	10	43
4,672	4,028	13,234	12,589	6,975	11,070	4,900	605	48,010	45,999	.....	.....	.....	2,011	44
1,144	616	3,454	7,588	8,097	2,400	1,100	160	30,150	28,760	.....	.....	.....	1,390	45
13,706	12,541	25,816	34,158	28,560	255,859	9,887	95	157,885	84,568	31,124	.....	.....	42,193	46
6,288	1,451	2,459	16,386	69,266	.....	1,650	3,682	102,932	76,051	.....	26,881	.....	.....	47
17,641	10,090	28,025	56,466	28,507	32,110	14,595	2,021	381,405	315,682	.....	.....	23,783	41,940	48
1,875	1,340	3,258	10,766	1,218	.....	.....	175	78,257	78,257	.....	.....	.....	.....	49
506	1,395	4,099	10,863	.....	.....	750	18,359	114,996	13,000	14,770	.....	.....	87,226	50
1,104	1,009	883	3,258	.....	.....	579	10,300	58,718	32,652	26,066	.....	.....	.....	51

[3] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed

Digitized by Google

TABLE 133.—COMMERCIAL CENTRAL ELECTRIC STATIONS—NUMBER OF SALARIED EMPLOYEES AND TOTAL SALARIES, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	TOTAL.		GENERAL OFFICERS OF CORPORATION.		GENERAL MANAGERS, SUPERINTENDENTS, ETC.		CLERKS AND BOOKKEEPERS.	
		Number.	Salaries.	Number.	Salaries.	Number	Salaries	Number.	Salaries.
United States	3,462	11,375	$10,738,955	1,761	$2,202,028	3,268	$4,243,307	6,346	$4,293,620
Alabama	27	82	64,583	11	13,119	28	28,600	43	22,864
Arizona	15	58	55,596	15	13,311	21	29,854	22	12,431
Arkansas	50	60	41,070	7	3,089	31	27,631	22	10,350
California	115	900	1,120,694	72	144,098	209	389,166	619	587,430
Colorado	49	211	214,710	34	50,162	68	91,332	109	73,216
Connecticut	36	160	157,749	54	57,134	39	54,630	67	45,985
Delaware[1]	8	84	79,315	11	23,516	15	20,015	58	35,784
Florida	24	45	25,514	6	2,410	22	15,839	17	7,265
Georgia	34	54	52,087	10	10,690	26	31,238	18	10,159
Idaho	40	68	78,955	11	20,955	27	38,174	30	19,826
Illinois	271	961	930,231	109	133,774	239	338,383	613	458,074
Indiana	132	355	254,827	72	65,686	119	108,107	164	81,034
Iowa	141	225	158,729	58	39,741	82	79,057	85	39,931
Kansas	79	139	113,995	23	19,905	64	65,928	52	28,162
Kentucky	69	108	89,391	14	23,356	43	44,050	51	21,985
Louisiana	21	81	73,409	18	24,652	18	19,117	45	29,640
Maine	77	151	95,679	37	23,283	63	49,326	51	23,070
Maryland	28	154	154,855	27	47,122	31	45,893	96	61,840
Massachusetts	96	595	649,248	122	174,925	119	224,813	354	249,510
Michigan	130	378	290,514	47	49,496	125	132,745	206	98,273
Minnesota	79	195	186,673	28	37,613	73	93,942	94	55,118
Mississippi	29	47	36,335	9	9,082	20	19,311	18	7,942
Missouri	104	423	410,215	45	74,144	120	171,617	258	164,454
Montana	31	119	172,111	23	38,385	39	75,619	57	58,107
Nebraska	73	96	90,696	18	20,985	44	49,684	34	20,027
Nevada	9	23	27,071	1	250	12	16,970	10	9,851
New Hampshire	52	104	80,918	38	24,619	32	36,472	34	19,827
New Jersey	57	392	415,904	53	111,866	81	115,749	258	188,289
New Mexico	15	27	21,505	6	2,799	15	14,230	6	4,476
New York	267	1,821	1,745,757	191	336,488	369	569,594	1,261	839,675
North Carolina	35	32	20,750	8	3,520	15	14,170	9	3,060
North Dakota	21	39	32,898	8	5,918	17	18,460	14	8,520
Ohio	167	454	442,096	85	119,074	119	150,103	250	172,919
Oklahoma	58	107	83,217	16	13,656	42	42,443	49	27,118
Oregon	50	112	127,797	7	16,950	41	58,482	64	52,365
Pennsylvania	282	1,144	1,026,502	204	195,516	315	414,610	625	416,376
Rhode Island	6	71	100,927	6	25,601	16	33,595	49	41,731
South Carolina	23	72	52,958	18	15,466	25	25,881	29	11,611
South Dakota	29	49	48,170	9	12,305	28	27,343	12	8,522
Tennessee	50	86	71,775	11	19,240	38	35,663	37	16,872
Texas	209	361	265,755	68	61,184	124	118,402	169	86,169
Utah	22	52	48,183	5	1,230	31	40,090	16	6,863
Vermont	47	89	59,945	19	8,680	31	31,927	39	19,338
Virginia	37	51	31,072	11	5,030	25	19,762	15	6,280
Washington	65	190	213,192	26	45,245	68	89,067	96	78,880
West Virginia	43	79	48,065	24	7,245	37	31,770	18	9,050
Wisconsin	142	236	158,595	55	44,073	88	77,313	93	37,209
Wyoming	18	35	28,722	11	5,440	14	17,140	10	6,142
Alaska	9	27	52,350	5	10,680	16	32,500	6	9,170
Hawaii and Porto Rico[2]	6	30	32,091	5	521	12	20,001	13	11,569

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.
[2] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 134.—COMMERCIAL CENTRAL ELECTRIC STATIONS—AVERAGE NUMBER OF WAGE-EARNERS AND TOTAL WAGES, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	TOTAL.		FOREMEN.		INSPECTORS.		ENGINEERS.		ALL OTHER EMPLOYEES (INCLUDING FIREMEN, DYNAMO AND SWITCHBOARD MEN, LINEMEN, MECHANICS, AND LAMP TRIMMERS).	
		Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
United States	3,462	30,691	$21,196,354	1,344	$1,446,048	860	$668,465	4,446	$3,484,231	24,041	$15,597,610
Alabama	27	167	100,980	9	6,970	4	2,989	35	23,715	119	67,306
Arizona	15	90	75,067	6	6,190	1	900	21	24,573	62	43,404
Arkansas	50	138	85,394	2	1,470	.....	.....	40	29,209	96	54,715
California	115	2,143	1,910,087	114	154,213	37	39,580	120	132,953	1,872	1,583,341
Colorado	49	688	547,955	41	52,914	6	6,360	82	73,549	559	415,132
Connecticut	36	543	338,800	28	30,228	11	8,148	69	63,313	435	237,111
Delaware[1]	8	243	170,568	7	7,368	9	6,690	23	20,266	204	136,244
Florida	24	90	52,617	3	2,582	.....	.....	27	17,832	60	32,203
Georgia	34	115	69,556	7	7,760	.....	.....	23	14,876	85	46,920
Idaho	40	110	83,956	11	10,530	3	1,500	21	15,446	75	56,480
Illinois	271	2,393	1,656,641	73	70,864	159	102,027	413	315,451	1,748	1,168,299
Indiana	132	931	517,215	29	23,584	17	13,088	190	128,988	695	351,555
Iowa	141	464	289,165	24	20,006	4	2,915	170	113,527	266	152,717
Kansas	79	296	192,636	11	10,144	6	4,296	102	73,437	177	104,759
Kentucky	69	413	172,573	12	9,505	2	1,200	90	59,737	309	102,131
Louisiana	21	363	255,546	7	8,400	10	9,240	33	30,083	313	207,823
Maine	77	322	192,777	16	14,261	6	3,857	42	27,805	258	146,854
Maryland	28	473	314,029	23	21,969	19	18,240	51	40,823	380	232,997
Massachusetts	96	1,853	1,417,006	77	81,432	68	57,509	204	201,867	1,504	1,076,198
Michigan	130	828	527,166	55	51,997	27	17,741	153	99,340	593	358,088
Minnesota	79	592	388,691	26	19,590	17	15,842	95	77,040	454	276,219
Mississippi	29	80	44,321	4	5,040	.....	.....	27	18,740	49	20,541
Missouri	104	1,191	779,857	50	53,466	52	38,943	129	90,721	960	596,727
Montana	31	190	181,817	17	25,740	5	4,390	28	29,397	140	122,290
Nebraska	73	235	177,856	7	6,720	7	5,400	60	43,411	161	122,325
Nevada	9	55	50,193	5	6,750	.....	.....	7	6,055	43	37,388
New Hampshire	52	308	200,171	13	12,186	2	1,560	31	28,327	262	158,098
New Jersey	57	1,338	938,756	29	27,537	32	20,853	146	134,366	1,131	756,000
New Mexico	15	56	45,476	3	3,480	.....	.....	17	17,028	36	24,968
New York	267	5,679	3,947,027	248	302,620	160	132,552	383	340,363	4,888	3,171,492
North Carolina	35	85	38,209	2	1,500	.....	.....	17	9,681	66	27,028
North Dakota	21	85	57,744	4	4,400	1	720	32	24,247	48	28,377
Ohio	167	1,160	806,868	47	47,385	51	40,555	264	198,559	798	520,369
Oklahoma	58	257	154,441	13	10,695	2	1,166	89	64,521	153	78,059
Oregon	50	334	277,624	26	27,510	7	6,487	47	44,343	254	199,284
Pennsylvania	282	3,146	2,060,646	129	139,747	89	69,908	445	347,178	2,483	1,503,813
Rhode Island	6	375	247,020	12	13,360	11	9,614	12	12,634	340	211,412
South Carolina	23	119	56,347	11	6,588	3	1,590	19	11,415	86	36,754
South Dakota	29	95	60,433	4	2,246	.....	.....	33	21,651	58	36,536
Tennessee	50	211	108,476	6	4,900	7	5,750	50	31,825	148	66,001
Texas	209	852	480,576	34	29,740	7	4,327	261	167,298	550	279,211
Utah	22	119	91,976	3	2,460	1	960	13	9,609	102	78,947
Vermont	47	160	103,245	17	14,289	5	3,419	26	18,966	112	66,571
Virginia	37	78	39,321	3	1,715	.....	.....	30	16,340	45	21,266
Washington	65	554	454,786	42	53,110	1	840	67	63,503	444	337,333
West Virginia	43	150	100,018	6	4,520	.....	.....	57	43,268	87	52,230
Wisconsin	142	463	285,636	25	23,127	11	7,309	134	89,363	293	165,837
Wyoming	18	61	49,089	3	3,240	.....	.....	18	17,592	40	28,257
Alaska	9	49	79,021	4	9,120	1	1,800	16	25,085	28	43,016
Hawaii and Porto Rico[2]	6	80	53,418	3	3,600	4	3,380	6	8,770	67	37,668

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.
[2] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 135.—COMMERCIAL CENTRAL ELECTRIC STATIONS—ANALYSIS OF MISCELLANEOUS EXPENSES, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	Total expenses.	Rent of stations, line-wire supports, conduits, etc.	Rent of offices.	Taxes.	Injuries and damages.	Insurance.	Ordinary repairs of buildings and machinery.	All other expenses.
United States	3,462	$25,611,771	$2,317,099	$566,472	$6,345,796	$602,523	$1,467,936	$3,986,586	$10,325,359
Alabama	27	131,921	151	8,705	34,704	1,648	13,533	22,333	50,847
Arizona	15	52,463	840	3,185	13,749	1,623	4,022	11,429	17,615
Arkansas	50	51,474	2,060	1,504	7,045	3,050	7,965	13,627	16,223
California	115	2,191,198	2,890	58,477	491,455	26,399	82,157	468,241	1,061,579
Colorado	49	550,651	5,797	25,361	120,656	10,363	38,106	81,149	269,219
Connecticut	36	299,336	719	6,523	44,177	5,528	16,154	74,135	152,100
Delaware[1]	8	255,886	.....	2,765	59,016	6,946	7,870	63,459	115,830
Florida	24	26,956	.....	1,560	6,131	600	3,430	5,696	9,539
Georgia	34	91,575	4,000	4,379	19,038	172	3,631	10,731	49,624
Idaho	40	65,423	5,928	5,356	11,042	238	2,790	4,939	35,130
Illinois	271	1,792,537	47,525	56,946	545,268	85,043	129,969	330,857	596,929
Indiana	132	507,802	1,427	19,753	111,488	11,484	35,769	164,134	163,747
Iowa	141	225,368	909	12,436	49,744	7,699	23,620	43,505	87,455
Kansas	79	167,264	817	8,228	33,150	3,232	13,761	30,181	77,895
Kentucky	69	199,483	297	3,998	81,962	5,994	17,151	37,937	52,144
Louisiana	21	302,481	.....	4,266	105,919	11,720	11,687	20,488	148,401
Maine	77	216,552	104	4,314	46,673	8,318	15,441	26,578	115,124
Maryland	28	467,832	93,317	10,916	73,338	20,528	25,062	49,855	194,816
Massachusetts	96	1,701,957	32,326	25,962	677,379	13,176	136,243	267,984	548,887
Michigan	130	618,848	69,685	12,965	167,917	7,405	26,259	110,975	223,642
Minnesota	79	339,160	2,465	13,190	136,425	10,181	20,294	54,549	102,056
Mississippi	29	43,372	.....	1,110	8,941	3,813	6,456	11,413	11,639
Missouri	104	927,142	16,525	21,960	245,671	23,796	51,984	143,223	423,983
Montana	31	316,895	1,354	10,667	78,076	7,109	7,020	19,475	193,194
Nebraska	73	171,365	240	7,009	55,057	2,847	14,577	37,996	53,639
Nevada	9	54,760	12,620	4,130	11,558	56	6,493	6,142	13,761
New Hampshire	52	161,600	309	5,898	39,117	2,505	20,669	34,420	58,682
New Jersey	57	633,584	4,951	21,002	207,360	20,934	46,458	110,714	222,165
New Mexico	15	40,436	.....	1,004	6,682	409	2,356	6,760	23,225
New York	267	6,655,302	1,212,541	75,616	1,579,845	179,944	317,854	797,964	2,491,538
North Carolina	35	27,635	300	874	5,565	80	3,245	5,071	12,500
North Dakota	21	33,001	492	1,211	9,389	952	2,643	9,445	8,869
Ohio	167	1,549,528	617,660	21,289	276,431	34,233	34,359	172,737	392,819
Oklahoma	58	162,108	1,470	6,257	15,893	1,978	13,695	22,857	99,958
Oregon	50	195,959	120	6,305	62,864	1,007	10,178	49,867	65,618
Pennsylvania	282	2,304,858	142,327	37,892	421,169	29,078	142,790	312,045	1,219,557
Rhode Island	6	226,833	154	5,700	99,853	1,241	27,621	14,825	77,439
South Carolina	23	163,405	17,012	2,228	20,986	427	4,915	20,350	97,487
South Dakota	29	26,774	.....	1,764	6,946	230	3,250	4,808	9,776
Tennessee	50	138,440	100	3,513	29,836	1,943	9,351	39,247	54,450
Texas	209	559,582	700	11,708	98,895	31,157	34,661	95,591	286,870
Utah	22	67,092	3,000	3,222	22,780	2,100	171	5,545	30,274
Vermont	47	138,447	1,441	4,224	17,286	33	10,685	31,738	73,040
Virginia	37	29,350	137	3,349	4,788	1,448	3,687	2,808	13,133
Washington	65	362,788	2,701	5,855	108,224	4,836	19,373	64,290	157,509
West Virginia	43	66,921	960	2,253	11,814	4,400	7,877	18,949	20,668
Wisconsin	142	263,420	8,728	7,974	57,122	4,156	27,631	44,806	113,003
Wyoming	18	35,007	.....	1,669	7,372	464	3,023	10,718	11,761
Alaska	9	29,192	.....	480	3,583	.....	720	5,671	18,738
Hawaii and Porto Rico[2]	6	41,182	235	3,300	11,433	.....	1,965	6,866	17,383

[1] Includes 1 station in District of Columbia, in order that the operations of individual stations may not be disclosed.
[2] Includes 1 municipal station in Porto Rico, in order that the operations of individual stations may not be disclosed.

Digitized by Google

TABLE 136.—MUNICIPAL CENTRAL ELECTRIC STATIONS—SUBSTATION EQUIPMENT, MOTORS, TRANSFORMERS, METERS, CUSTOMERS, AND OUTPUT OF STATIONS, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	SUBSTATION PLANTS.				STATIONARY MOTORS.		TRANSFORMERS IN CIRCUITS FOR CUSTOMERS.		Number of meters on consumption circuits.	Number of customers furnished electric current.	OUTPUT OF STATIONS, KILOWATT HOURS.	
		Total kilowatt capacity.	Transformers.		Kilowatt capacity of miscellaneous apparatus.	Number.	Horsepower.	Number.	Kilowatts.			Total for year.	Average per day.
			Number.	Kilowatts.									
United States	1,252	11,721	164	10,563	1,158	4,507	31,689	44,152	161,397	215,154	283,625	289,462,788	810,820
Alabama	28					42	238	649	1,946	2,180	4,085	2,937,878	8,477
Arkansas	13					6	10	370	1,008	954	2,760	2,278,489	6,242
California	14	373	7	373		295	2,206	1,328	4,947	6,451	7,016	3,840,413	10,982
Colorado	7					15	133	251	770	1,003	1,392	508,268	2,383
Connecticut	5					155	1,132	185	1,651	2,146	2,367	3,206,790	8,786
Delaware	6					1	4	64	240	389	1,071	1,174,935	3,219
Florida	13					121	915	934	4,414	5,241	5,944	7,407,231	20,499
Georgia	59	184	4	184		87	477	1,994	4,877	6,893	9,853	8,158,309	22,468
Illinois	112	3,591	70	3,591		67	256	2,932	7,851	8,872	15,760	27,971,563	76,939
Indiana	68					407	3,342	3,660	15,584	19,839	25,371	23,946,094	67,346
Iowa	51					202	611	855	2,846	8,952	11,169	7,341,898	20,254
Kansas	32					211	1,076	896	3,264	4,415	6,453	6,670,932	19,112
Kentucky	14					76	566	962	2,695	2,763	3,462	4,118,765	11,287
Louisiana	21					17	45	589	1,884	2,431	3,728	3,988,155	10,998
Maine	4	497	10	497		8	27	236	490	325	335	1,936,505	5,637
Maryland	8					45	412	162	759	432	706	2,309,720	6,328
Massachusetts	24	262	9	262		507	4,388	2,182	10,581	9,221	8,986	13,042,167	35,734
Michigan	104	2,165	15	1,032	1,133	328	2,009	4,048	15,614	24,019	27,404	29,455,269	78,609
Minnesota	92					300	1,643	1,881	6,247	17,056	19,911	12,138,290	34,228
Mississippi	39					27	307	1,069	3,629	3,999	6,373	7,145,801	19,908
Missouri	58					86	1,515	1,857	6,032	6,331	10,804	11,489,766	32,150
Nebraska	25					55	195	549	2,674	4,437	5,249	3,689,363	10,294
New Hampshire	4	75	1	75				232	738	462	657	805,112	2,209
New Jersey	7					20	81	282	1,154	1,347	1,423	1,170,145	3,294
New York	47	300	5	300		113	951	1,927	6,064	6,400	7,350	10,905,131	36,374
North Carolina	36	180	4	180		81	929	903	3,359	4,535	6,479	5,085,607	15,017
North Dakota	8					15	46	111	396	1,311	1,539	1,019,510	2,795
Ohio	105	90	4	90		338	1,681	4,277	13,550	19,274	23,949	29,294,069	82,725
Oklahoma	14					8	25	294	956	918	2,060	1,928,343	5,400
Oregon	11	250	1	250		2	8	125	514	686	1,740	772,695	2,356
Pennsylvania	45	145	2	120	25	108	790	1,453	5,288	5,332	8,036	13,887,298	38,166
South Carolina	17	246	7	246		71	451	859	1,754	2,167	2,651	2,041,839	6,588
South Dakota	8	140	4	140		9	39	99	580	1,601	1,653	1,030,324	2,945
Tennessee	28	75	6	75		18	280	756	2,180	1,832	4,879	7,354,947	20,258
Texas	9					90	566	800	2,082	1,926	2,764	4,613,600	12,640
Utah	9	300	3	300		81	540	278	1,402	596	3,920	3,848,250	10,652
Vermont	13	218	3	218		66	722	516	2,557	2,150	3,190	3,762,490	10,309
Virginia	14					98	864	464	1,716	974	2,314	2,408,541	6,598
Washington	6	2,400	4	2,400		215	1,734	1,304	11,018	16,292	17,306	7,099,655	19,453
West Virginia	5					2	40	68	235	46	370	1,714,215	4,741
Wisconsin	64	230	5	230		81	378	1,468	5,124	8,006	10,069	4,958,091	13,663
All other states [1]	5					33	57	283	725	950	1,077	1,006,305	2,757

[1] Includes states having less than 3 stations, in order that the operations of individual stations may not be disclosed. These stations are distributed as follows: Idaho, 2; Montana, 2; Rhode Island, 1.

Digitized by Google

TABLE 137.—MUNICIPAL CENTRAL ELECTRIC STATIONS—PRIMARY POWER

	STATE OR TERRITORY.	Number of stations.	PRIMARY POWER.																	
			Aggregate.		Steam engines.								Steam turbines.							
					Total.		500 H. P. and under.		Over 500 H. P. but under 1,000 H. P.		1,000 H. P. but under 2,000 H. P.		Total.		500 H. P. and under.		Over 500 H. P. but under 1,000 H. P.		1,000 H. P. but under 2,000 H. P.	
			Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.
1	United States..	1,252	2,017	321,351	1,685	264,033	1,648	236,893	33	22,840	4	4,300	29	19,385	16	4,485	5	3,500	6	6,100
2	Alabama	28	33	4,538	31	4,206	31	4,206												
3	Arkansas	13	18	2,909	18	2,909	18	2,909												
4	California	14	22	5,230	19	4,250	19	4,250					1	750			1	750		
5	Colorado	7	9	970	9	970	9	970												
6	Connecticut	5	20	4,590	13	3,815	11	2,465	2	1,350										
7	Delaware	6	12	1,340	12	1,340	12	1,340												
8	Florida	13	35	7,969	20	3,816	19	3,066	1	750			9	3,990	6	990			3	3,000
9	Georgia	59	71	9,964	69	9,784	69	9,784												
10	Illinois	112	183	30,847	168	30,527	154	19,027	11	8,200	3	3,300								
11	Indiana	68	112	20,446	94	17,455	92	16,205	2	1,250			3	2,000			3	2,000		
12	Iowa	51	80	9,811	70	9,238	69	8,688	1	550										
13	Kansas	32	50	7,521	43	6,909	43	6,909												
14	Kentucky	14	23	4,584	23	4,584	21	3,084	1	500	1	1,000								
15	Louisiana	21	35	4,287	35	4,287	35	4,287												
16	Maine	4	9	2,245	1	500	1	500												
17	Maryland	8	21	2,455	13	2,310	13	2,310												
18	Massachusetts	24	60	15,805	46	9,842	44	8,542	2	1,300			3	4,400					2	2,100
19	Michigan	104	179	31,504	139	23,053	135	20,303	4	2,750			3	3,875	2	875				
20	Minnesota	92	140	17,325	122	15,165	122	15,165					1	300	1	300				
21	Mississippi	39	63	8,167	56	7,957	56	7,957												
22	Missour:	58	77	12,046	72	11,795	70	10,395	2	1,400										
23	Nebraska	25	39	4,231	30	3,792	30	3,792												
24	New Hampshire	4	7	915	3	310	3	310												
25	New Jersey	7	12	1,697	9	1,532	9	1,532												
26	New York	47	77	12,739	59	9,208	59	9,208					2	1,250	1	500	1	750		
27	North Carolina	36	51	6,775	45	6,334	45	6,334												
28	North Dakota	8	13	1,425	13	1,425	13	1,425												
29	Ohio	105	188	29,427	168	25,478	166	24,438	2	1,040			4	2,200	3	1,200			1	1,000
30	Oklahoma	14	17	2,195	17	2,195	17	2,195												
31	Oregon	11	10	604	5	347	5	347												
32	Pennsylvania	45	88	13,541	77	12,530	75	11,030	2	1,500										
33	South Carolina	17	21	2,605	21	2,605	21	2,605												
34	South Dakota	8	15	1,768	10	1,510	10	1,510												
35	Tennessee	28	49	6,820	44	6,580	42	5,080	2	1,500										
36	Texas	9	14	2,940	13	2,865	12	2,115	1	750										
37	Utah	9	11	2,720	2	210	2	210												
38	Vermont	13	22	4,948	3	490	3	490					1	450	1	450				
39	Virginia	14	18	3,859	9	1,406	9	1,406												
40	Washington	6	7	5,409	2	365	2	365												
41	West Virginia	5	7	1,575	7	1,575	7	1,575												
42	Wisconsin	64	94	9,870	71	8,029	71	8,029					2	170	2	170				
43	All other states[1]	5	5	735	4	535	4	535												

[1] Includes states having less than 3 stations, in order that the operations of individual stations may not be disclosed. These stations are distributed as follows: Idaho, 2; Montana, 2; Rhode Island, 1.

Digitized by Google

AND GENERATING EQUIPMENT, BY STATES AND TERRITORIES: 1907.

PRIMARY POWER—continued.														GENERATING AND OTHER MAIN-STATION EQUIPMENT.						
Steam turbines—Con.		Water wheels.								Gas engines.		Auxiliary engines.		Dynamos.						
														Aggregate.						
2,000 H. P. but under 5,000 H. P.		Total.		500 H. P. and under.		Over 500 H. P. but under 1,000 H. P.		1,000 H. P. but under 2,000 H. P.		2,000 H. P. but under 5,000 H. P.				Total.		Under 200 K. W.		200 K. W. but under 500 K. W.		
Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	
2	5,300	153	30,347	149	23,947	1	800	1	1,200	2	4,400	78	6,082	72	1,504	2,395	209,016	2,208	151,013	172	44,753	1
.....	.....	2	332	2	332	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	36	3,252	33	2,612	3	640	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23	2,044	22	1,844	1	200	3
.....	.....	1	200	1	200	.....	.....	.....	.....	.....	.....	.....	.....	1	30	23	2,868	15	1,038	8	1,830	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	665	12	665	.....	.....	5
.....	.....	2	90	2	90	.....	.....	.....	.....	.....	.....	5	685	.....	.....	19	2,710	14	1,205	5	1,505	6
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17	970	17	970	.....	.....	7
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	40	5	123	33	3,688	30	3,008	3	680	8
.....	.....	2	180	2	180	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	79	7,115	73	5,875	6	1,240	9
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11	302	4	18	264	18,931	258	15,781	3	900	10
.....	.....	6	531	6	531	.....	.....	.....	.....	.....	.....	4	340	5	120	148	15,352	126	8,944	21	5,908	11
.....	.....	3	355	3	355	.....	.....	.....	.....	.....	.....	2	166	5	52	95	6,360	93	5,860	2	500	12
.....	.....	1	200	1	200	.....	.....	.....	.....	.....	.....	5	377	1	35	56	4,914	51	3,784	5	1,130	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30	2,809	26	1,559	3	750	14
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	42	2,905	40	2,405	2	500	15
.....	.....	8	1,745	8	1,745	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	862	6	362	2	500	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	35	6	110	20	1,312	19	982	1	330	17
1	2,300	6	1,185	6	1,185	.....	.....	.....	.....	.....	.....	4	328	1	50	80	9,822	67	4,647	12	3,675	18
1	3,000	29	4,229	28	3,029	.....	.....	1	1,200	.....	.....	3	269	5	78	205	19,652	190	13,356	14	4,296	19
.....	.....	10	1,496	10	1,496	.....	.....	.....	.....	.....	.....	6	361	1	3	161	11,209	153	9,209	8	2,000	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7	210	59	5,264	54	4,189	5	1,075	21
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	70	4	181	94	7,627	90	6,252	4	1,375	22
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	386	3	53	40	3,011	38	2,611	2	400	23
.....	.....	4	605	4	605	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	545	5	545	.....	.....	24
.....	.....	1	112	1	112	.....	.....	.....	.....	.....	.....	2	53	.....	.....	12	1,217	11	967	1	250	25
.....	.....	13	2,045	13	2,045	.....	.....	.....	.....	.....	.....	2	230	1	6	93	8,367	85	6,267	7	1,600	26
.....	.....	2	286	2	286	.....	.....	.....	.....	.....	.....	.....	.....	4	155	58	4,849	56	4,449	2	400	27
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15	1,010	14	810	1	200	28
.....	.....	3	355	3	355	.....	.....	.....	.....	.....	.....	8	1,325	5	69	235	20,655	213	14,595	21	5,560	29
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17	1,385	16	1,185	1	200	30
.....	.....	2	175	2	175	.....	.....	.....	.....	.....	.....	3	82	.....	.....	11	491	11	491	.....	.....	31
.....	.....	2	285	2	285	.....	.....	.....	.....	.....	.....	9	726	.....	.....	118	8,861	112	7,009	4	852	32
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23	1,976	22	1,726	1	250	33
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	232	2	26	15	1,020	15	1,020	.....	.....	34
.....	.....	3	180	3	180	.....	.....	.....	.....	.....	.....	.....	.....	2	60	49	5,141	43	2,891	4	1,050	35
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	75	21	2,333	14	633	7	1,700	36
.....	.....	9	2,510	8	1,710	1	800	.....	.....	.....	.....	.....	.....	.....	.....	10	1,460	7	610	3	850	37
.....	.....	15	3,968	15	3,968	.....	.....	.....	.....	.....	.....	.....	.....	3	20	22	2,797	16	1,315	6	1,482	38
.....	.....	9	2,453	9	2,453	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23	2,132	20	1,432	3	700	39
.....	.....	4	5,040	2	640	.....	.....	.....	.....	2	4,400	.....	.....	1	4	6	3,810	4	510	.....	.....	40
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14	717	14	717	.....	.....	41
.....	.....	15	1,570	15	1,570	.....	.....	.....	.....	.....	.....	1	75	5	26	95	6,249	94	6,024	1	225	42
.....	.....	1	200	1	200	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	659	9	659	.....	.....	43

Digitized by Google

TABLE 137.—MUNICIPAL CENTRAL ELECTRIC STATIONS—PRIMARY POWER AND

	STATE OR TERRITORY.	GENERATING AND OTHER MAIN-STATION EQUIPMENT—continued.																	
		Dynamos—Continued.																	
		Aggregate—Continued.						Direct-current, constant-voltage.						Direct-current, constant-amperage.					
		500 K. W. but under 1,000 K. W.		1,000 K. W. but under 2,000 K. W.		2,000 K. W. but under 5,000 K. W.		Total.		Under 200 K. W.		200 K. W. but under 500 K. W.		Total.		Under 200 K. W.		200 K. W. but under 500 K. W.	
		Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.
1	United States	11	6,450	3	4,800	1	2,000	511	26,754	506	25,554	5	1,200	439	19,239	435	17,971	4	1,268
2	Alabama							5	297	5	297								
3	Arkansas							5	186	5	186			4	268	4	268		
4	California							3	50	3	50			2	45	2	45		
5	Colorado													1	22	1	22		
6	Connecticut							7	725	7	725			1	60	1	60		
7	Delaware							10	410	10	410								
8	Florida							6	600	5	400	1	200	3	375	3	375		
9	Georgia							6	198	6	198			2	50	2	50		
10	Illinois	3	2,250					42	1,768	42	1,768			117	6,407	117	6,407		
11	Indiana	1	500					21	1,527	21	1,527			36	1,953	34	1,185	2	768
12	Iowa							45	2,724	44	2,424	1	300	5	179	5	179		
13	Kansas							13	715	13	715			2	75	2	75		
14	Kentucky	1	500					7	341	7	341			7	258	7	258		
15	Louisiana							17	759	17	759			1	38	1	38		
16	Maine													4	112	4	112		
17	Maryland							6	272	6	272			9	270	9	270		
18	Massachusetts			1	1,500			8	192	8	192			20	470	20	470		
19	Michigan					1	2,000	23	1,382	23	1,382			55	2,241	55	2,241		
20	Minnesota							91	4,742	89	4,242	2	500	9	248	9	248		
21	Mississippi							11	485	11	485								
22	Missouri							21	958	21	958			12	445	12	445		
23	Nebraska							17	948	17	948			1	75	1	75		
24	New Hampshire																		
25	New Jersey							1	42	1	42								
26	New York	1	500					15	617	15	617			12	869	10	369	2	500
27	North Carolina							9	509	9	509			5	161	5	161		
28	North Dakota							9	475	8	275	1	200	2	130	2	130		
29	Ohio	1	500					42	2,533	42	2,533			47	1,571	47	1,571		
30	Oklahoma							3	150	3	150								
31	Oregon							5	121	5	121								
32	Pennsylvania	2	1,000					12	557	12	557			44	1,755	44	1,755		
33	South Carolina							3	41	3	41								
34	South Dakota							6	305	6	305			1	10	1	10		
35	Tennessee	2	1,200					13	686	13	686			1	39	1	39		
36	Texas							3	93	3	93			7	240	7	240		
37	Utah																		
38	Vermont													3	60	3	60		
39	Virginia							3	108	3	108			7	209	7	209		
40	Washington			2	3,300														
41	West Virginia													10	417	10	417		
42	Wisconsin							22	1,163	22	1,163			8	143	8	143		
43	All other states[1]							1	75	1	75			1	44	1	44		

[1] Includes states having less than 3 stations, in order that the operations of individual stations may not be disclosed. These stations are distributed as follows: Idaho, 2; Montana, 2; Rhode Island, 1.

Digitized by Google

GENERATING EQUIPMENT, BY STATES AND TERRITORIES: 1907—Continued.

GENERATING AND OTHER MAIN-STATION EQUIPMENT—continued.																			
Dynamos—Continued.												Transformers.		Boosters.		Rotaries.		Storage-battery cells in main stations.	Kilowatt capacity of miscellaneous apparatus.	
Alternating single-phase and polyphase current.																				
Total.		Under 200 K. W.		200 K. W. but under 500 K. W.		500 K. W. but under 1,000 K. W.		1,000 K. W. but under 2,000 K. W.		2,000 K. W. but under 5,000 K. W.										
Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.	Number.	Kilowatts.			
1,445	162,023	1,267	107,488	163	42,285	11	6,450	3	4,800	1	2,000	145	5,287	21	336	5	713	496	953	1
31	2,955	28	2,315	3	640														15	2
14	1,590	13	1,390	1	200														10	3
18	2,773	10	943	8	1,830							5	221							4
11	643	11	643																	5
11	1,925	6	420	5	1,505											1	100		60	6
7	560	7	560																	7
24	2,713	22	2,233	2	480							17	243			1	275		12	8
71	6,867	65	5,627	6	1,240									1	22				25	9
105	10,756	99	7,606	3	900	3	2,250					7	489	2	9					10
91	11,872	71	6,232	19	5,140	1	500					23	2,119			2	138			11
45	3,457	44	3,257	1	200									1	13			140	35	12
41	4,124	36	2,994	5	1,130							3	71						14	13
16	2,210	12	960	3	750	1	500							1	3					14
24	2,108	22	1,608	2	500													36		15
4	750	2	250	2	500															16
5	770	4	440	1	330									2	24			60		17
52	9,160	39	3,985	12	3,675			1	1,500											18
127	16,029	112	9,733	14	4,296					1	2,000	12	287	5	145				438	19
61	6,219	55	4,719	6	1,500							3	76	3	36			128	50	20
48	4,779	43	3,704	5	1,075							1	20						20	21
61	6,224	57	4,849	4	1,375							8	287			1	200		95	22
22	1,988	20	1,588	2	400															23
5	545	5	545																	24
11	1,175	10	925	1	250															25
66	6,881	60	5,281	5	1,100	1	500					9	214							26
44	4,179	42	3,779	2	400							4	93	1	30					27
4	405	4	405																14	28
146	16,551	124	10,491	21	5,560	1	500					20	471	4	50				165	29
14	1,235	13	1,035	1	200															30
6	370	6	370									1	17							31
62	6,549	56	4,697	4	852	2	1,000					4	12							32
20	1,935	19	1,685	1	250							13	270							33
8	705	8	705															132		34
35	4,416	29	2,166	4	1,050	2	1,200					2	35							35
11	2,000	4	300	7	1,700															36
10	1,460	7	610	3	850															37
19	2,737	13	1,255	6	1,482							6	240							38
13	1,815	10	1,115	3	700															39
6	3,810	4	510					2	3,300			1	2							40
4	300	4	300									1	2							41
65	4,943	64	4,718	1	225							3	103	1	4					42
7	540	7	540									2	15							43

Digitized by Google

TABLE 138.—MUNICIPAL CENTRAL ELECTRIC STATIONS—ANALYSIS

	STATE OR TERRITORY.	Number of stations.	ARC LIGHTING—NUMBER OF LAMPS WIRED FOR SERVICE.											
			Aggregate.	Total.				Direct-current.				Alternating-current.			
				Commercial.		Public.		Commercial.		Public.		Commercial.		Public.	
				Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.
1	United States	1,252	82,940	426	9,432	18,004	55,078	354	1,101	17,209	14,434	72	8,331	795	40,644
2	Alabama	28	726	3	54	44	625	.....	5	.....	34	3	49	44	591
3	Arkansas	13	609	3	32	9	565	3	1	9	336	.....	31	.....	229
4	California	14	865	20	40	96	709	.....	2	18	76	20	38	78	633
5	Colorado	7	125	.....	51	15	59	.....	.....	15	.....	.....	51	.....	59
6	Connecticut	5	711	.....	279	.....	432	.....	83	.....	115	.....	196	.....	317
7	Delaware	6	56	.....	2	2	52	.....	.....	2	.....	.....	2	.....	52
8	Florida	13	1,020	144	50	177	649	144	.....	177	6	.....	50	.....	643
9	Georgia	59	2,013	.....	122	138	1,753	.....	3	80	26	.....	119	58	1,727
10	Illinois	112	16,277	5	153	7,460	8,659	5	21	7,350	3,023	.....	132	110	5,636
11	Indiana	68	5,498	40	1,362	1,260	2,836	40	76	1,240	770	.....	1,286	20	2,066
12	Iowa	51	1,011	3	263	40	705	3	163	10	563	.....	100	30	142
13	Kansas	32	1,505	1	203	223	1,078	.....	6	223	190	1	197	.....	888
14	Kentucky	14	1,306	.....	201	282	823	.....	.....	282	262	.....	201	.....	561
15	Louisiana	21	608	.....	72	.....	536	.....	3	.....	140	.....	69	.....	396
16	Maine	4	622	.....	5	212	405	.....	.....	212	.....	.....	5	.....	405
17	Maryland	8	715	.....	163	74	478	.....	.....	74	314	.....	163	.....	164
18	Massachusetts	24	2,955	.....	853	412	1,690	.....	34	412	271	.....	819	.....	1,419
19	Michigan	104	10,541	112	1,385	1,993	7,051	91	141	1,792	1,571	21	1,244	201	5,480
20	Minnesota	92	2,386	2	693	226	1,465	2	297	218	685	.....	396	8	780
21	Mississippi	39	837	.....	55	.....	782	.....	1	.....	55	.....	54	.....	727
22	Missouri	58	2,349	.....	302	712	1,335	.....	20	668	299	.....	282	44	1,036
23	Nebraska	25	942	8	163	99	672	8	2	99	125	.....	161	.....	547
24	New Hampshire	4	9	.....	9	.....	.....	.....	.....	.....	.....	.....	9	.....	.....
25	New Jersey	7	175	.....	8	2	165	.....	.....	.....	.....	.....	8	2	165
26	New York	47	3,289	2	234	498	2,555	.....	.....	403	800	2	234	95	1,755
27	North Carolina	36	1,519	.....	168	54	1,297	.....	12	54	292	.....	156	.....	1,005
28	North Dakota	8	256	.....	39	16	201	.....	25	16	162	.....	14	.....	39
29	Ohio	105	9,517	53	675	1,389	7,400	50	65	1,317	1,675	3	610	72	5,725
30	Oklahoma	14	321	10	60	15	236	.....	9	.....	49	10	51	15	187
31	Oregon	11	52	.....	.....	.....	52	.....	.....	.....	3	.....	.....	.....	49
32	Pennsylvania	45	4,150	.....	157	1,338	2,655	.....	31	1,338	1,653	.....	126	.....	1,002
33	South Carolina	17	784	.....	46	.....	738	.....	.....	.....	.....	.....	46	.....	738
34	South Dakota	8	311	.....	13	.....	298	.....	12	.....	11	.....	1	.....	287
35	Tennessee	28	1,728	10	58	45	1,615	.....	12	31	105	10	46	14	1,510
36	Texas	9	1,053	.....	191	264	598	.....	10	264	125	.....	181	.....	473
37	Utah	9	147	.....	90	4	53	.....	.....	.....	.....	.....	90	4	53
38	Vermont	13	344	2	14	45	283	.....	.....	45	.....	2	14	.....	283
39	Virginia	14	604	.....	27	147	520	.....	.....	147	212	.....	27	.....	308
40	Washington	6	2,221	.....	820	.....	1,401	.....	.....	.....	.....	.....	820	.....	1,401
41	West Virginia	5	728	.....	.....	558	170	.....	.....	558	130	.....	.....	.....	40
42	Wisconsin	64	1,734	.....	278	140	1,316	.....	48	140	247	.....	230	.....	1,069
43	All other states[1]	5	231	8	42	15	166	8	19	15	109	.....	23	.....	57

[1] Includes states having less than 3 stations, in order that the operations of individual stations may not be disclosed. These stations are distributed as follows: Idaho, 2; Montana, 2; Rhode Island, 1.

Digitized by Google

OF SERVICE, BY STATES AND TERRITORIES: 1907.

INCANDESCENT LIGHTING—NUMBER OF LAMPS WIRED FOR SERVICE.									OTHER VARIETIES OF LAMPS—NERNST, VACUUM, VAPOR, ETC.		STATIONARY MOTORS.		
Aggregate.	Total.		16-candlepower.		32-candlepower.		All other candlepower.						
	Commercial.	Public.	Commercial.	Public.	Commercial.	Public.	Commercial.	Public.	Commercial.	Public.	Number.	Horsepower.	
4,052,448	3,882,211	170,237	3,369,506	117,866	137,026	29,169	375,679	23,202	7,738	1,132	4,507	31,689	1
42,223	40,522	1,701	39,476	1,479	820	133	226	89	2	.....	42	238	2
27,312	26,685	627	23,435	123	1,350	302	1,900	202	.....	.....	6	10	3
111,209	107,383	3,826	91,607	1,878	3,114	1,018	12,662	930	100	62	295	2,206	4
15,976	15,804	172	14,441	43	933	93	430	36	33	.....	15	133	5
53,177	52,576	601	52,326	.....	250	401	.....	200	15	.....	155	1,132	6
9,925	9,105	820	8,355	500	.....	140	750	180	.....	.....	1	4	7
88,169	86,696	1,473	82,122	1,000	3,440	251	1,134	222	.....	.....	121	915	8
114,454	111,614	2,840	90,893	1,970	9,457	229	11,264	641	3	.....	87	477	9
203,659	186,031	17,628	157,425	13,008	4,850	2,908	23,756	1,712	202	285	67	256	10
298,160	293,436	4,724	258,953	3,756	9,547	752	24,936	216	255	.....	407	3,342	11
141,168	136,640	4,528	118,663	1,188	7,193	2,800	10,784	540	8	30	202	611	12
79,420	77,642	1,778	67,278	1,329	5,409	328	4,955	121	35	133	211	1,076	13
54,426	52,794	1,632	48,562	1,320	1,893	132	2,339	180	150	.....	76	566	14
44,096	42,193	1,903	39,874	1,105	1,205	544	1,114	254	8	.....	17	45	15
8,806	6,279	2,527	5,479	1,850	300	132	500	545	.....	.....	8	27	16
11,632	7,797	3,835	7,405	3,591	50	188	342	56	20	.....	45	412	17
223,293	211,914	11,379	205,568	5,816	913	1,932	5,433	3,631	395	84	507	4,388	18
418,258	385,648	32,610	329,063	29,752	10,762	1,796	45,823	1,062	1,083	285	328	2,009	19
270,880	264,608	6,272	229,954	3,392	13,449	2,448	21,205	432	626	.....	300	1,643	20
88,008	86,625	1,383	75,819	578	4,654	524	6,152	281	2	.....	27	307	21
133,178	129,733	3,445	121,335	683	2,609	1,187	5,789	1,575	58	.....	86	1,515	22
81,227	78,458	2,769	72,285	2,211	4,240	365	1,933	193	169	.....	55	195	23
13,572	13,099	473	8,029	.....	720	90	4,350	383	.....	.....	.....	.....	24
28,154	26,740	1,414	26,140	400	200	713	400	301	100	.....	20	81	25
183,729	177,106	6,623	114,545	5,745	3,541	315	59,020	563	25	140	113	951	26
98,703	96,877	1,826	79,875	982	4,642	338	12,360	506	34	.....	81	929	27
23,604	23,265	339	19,009	185	1,406	74	2,850	80	100	.....	15	46	28
361,179	347,199	13,980	307,508	11,389	9,396	1,436	30,295	1,155	211	22	338	1,681	29
17,613	17,085	528	14,345	368	1,665	100	1,075	60	5	.....	8	25	30
10,145	9,776	369	6,860	123	131	193	2,785	63	.....	.....	2	8	31
127,759	114,576	13,183	102,937	11,808	2,878	1,296	8,761	79	127	.....	108	790	32
46,624	45,199	1,425	39,478	1,061	3,364	225	2,357	139	6	.....	71	451	33
36,010	35,096	914	31,078	700	212	211	3,806	3	10	.....	9	39	34
53,156	48,996	4,160	44,390	1,953	2,206	977	2,400	1,230	20	.....	18	280	35
26,812	24,592	2,220	24,460	1,280	132	166	.....	774	.....	.....	90	566	36
22,670	21,231	1,439	16,326	616	1,612	523	3,293	300	7	.....	81	540	37
63,136	61,683	1,453	50,059	105	1,818	652	9,806	696	237	.....	66	722	38
30,338	29,825	513	28,471	235	593	185	761	93	.....	.....	98	864	39
215,242	210,161	5,081	166,989	872	9,230	1,438	33,942	2,771	3,532	88	215	1,734	40
3,108	2,848	260	2,048	48	63	208	737	4	.....	.....	2	40	41
157,392	152,109	5,283	135,341	3,255	5,089	1,346	11,679	682	94	3	81	378	42
14,846	14,565	281	11,300	169	1,690	90	1,575	22	66	.....	33	57	43

Digitized by Google

TABLE 139.—MUNICIPAL CENTRAL ELECTRIC STATIONS—CHARACTER OF SERVICE, BONDS, AND COST OF CONSTRUCTION AND EQUIPMENT, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	NUMBER OF STATIONS.									BONDS.			COST OF CONSTRUCTION AND EQUIPMENT.	
	Total.	Class.		Character of service.						Par value.		Interest.	Total.	During the year.
		Purely electric.	Composite.	Lighting.				Stationary motors.	All other electric service.	Authorized.	Outstanding.			
				Arc.		Incandescent.								
				Commercial.	Public.	Commercial.	Public.							
United States	1,252	521	731	541	1,092	1,153	1,018	350	168	$29,031,638	$25,343,654	$1,149,432	$42,879,447	$5,166,365
Alabama	28	6	22	10	27	28	24	6	2	538,500	508,500	26,225	489,817	65,420
Arkansas	13	6	7	6	12	11	10	2	3	231,600	195,100	10,736	417,056	17,757
California	14	6	8	7	12	12	13	10	3	493,000	406,400	19,433	908,974	394,315
Colorado	7	4	3	2	4	7	7	2	.....	25,700	22,700	1,257	120,643	10,971
Connecticut	5	3	2	3	4	5	5	3	2	737,500	737,500	33,150	719,708	56,664
Delaware	6	1	5	1	3	6	6	1	1	126,000	117,500	5,255	109,611	1,395
Florida	13	5	8	5	12	13	12	3	1	357,500	350,500	17,790	818,866	120,856
Georgia	59	22	37	21	58	57	52	11	1	1,045,500	971,400	48,517	1,127,594	103,852
Illinois	112	59	53	21	92	87	83	14	3	791,990	427,140	20,344	5,946,525	779,486
Indiana	68	23	45	38	62	63	48	24	8	1,013,228	726,551	37,668	2,253,178	296,075
Iowa	51	22	29	29	41	47	47	16	8	428,800	338,830	17,212	1,032,677	87,537
Kansas	32	17	15	15	29	29	23	14	5	472,000	426,000	18,639	747,197	101,596
Kentucky	14	10	4	3	12	12	9	3	.....	74,000	65,500	3,245	524,644	18,558
Louisiana	21	3	18	11	17	21	21	6	13	535,500	314,650	18,518	476,860	53,017
Maine	4	4	.....	1	3	2	3	2	.....	54,320	54,320	2,616	185,303	8,591
Maryland	8	5	3	1	4	4	6	1	.....	135,000	127,000	5,250	238,280	19,184
Massachusetts	24	17	7	14	19	24	23	18	6	2,042,870	1,814,312	68,760	2,755,981	357,737
Michigan	104	28	76	55	100	96	89	26	17	2,770,375	2,429,601	107,597	4,344,825	450,238
Minnesota	92	18	74	61	86	92	85	31	14	1,230,050	1,096,050	54,071	1,945,328	241,760
Mississippi	39	5	34	12	30	39	28	8	20	1,395,200	1,370,600	72,038	899,108	57,368
Missouri	58	36	22	21	49	55	45	6	3	1,338,550	1,081,200	50,189	1,311,189	136,801
Nebraska	25	4	21	10	19	24	20	4	.....	298,100	290,100	10,739	508,985	74,560
New Hampshire	4	3	1	1	.....	4	4	.....	.....	200,000	200,000	7,000	76,849	2,469
New Jersey	7	2	5	2	5	7	6	3	1	178,520	178,520	6,976	258,433	26,671
New York	47	29	18	16	42	41	31	16	3	1,054,090	889,200	34,453	1,532,127	156,609
North Carolina	36	17	19	17	33	36	29	12	3	990,900	923,400	48,132	816,279	97,101
North Dakota	8	1	7	3	8	7	6	1	1	108,040	108,040	5,902	145,012	28,993
Ohio	105	47	58	50	103	98	79	29	19	3,425,725	2,873,260	130,258	3,424,494	380,677
Oklahoma	14	3	11	9	14	14	12	2	3	480,000	480,000	22,560	202,350	39,194
Oregon	11	3	8	.....	5	11	11	1	2	274,500	235,100	10,638	121,646	14,342
Pennsylvania	45	36	9	20	41	36	36	14	2	1,245,300	1,168,200	47,654	1,697,084	87,668
South Carolina	17	7	10	11	17	17	16	10	6	305,500	305,500	16,165	412,526	45,908
South Dakota	8	3	5	3	8	6	6	1	.....	41,500	41,500	2,155	198,695	20,549
Tennessee	28	5	23	7	21	26	19	6	1	765,200	739,700	35,345	841,434	64,428
Texas	9	1	8	5	8	6	8	3	1	106,000	96,000	4,950	407,852	71,937
Utah	9	9	.....	5	5	9	9	6	1	197,880	191,880	9,065	335,156	21,611
Vermont	13	10	3	4	5	13	12	9	5	476,000	388,200	15,100	581,591	56,676
Virginia	14	11	3	3	11	12	9	4	2	245,000	240,000	10,390	452,014	31,342
Washington	6	6	.....	4	4	6	6	4	1	1,868,000	1,597,500	54,825	2,168,305	432,465
West Virginia	5	4	1	.....	4	3	3	1	.....	41,500	31,200	1,409	100,872	990
Wisconsin	64	18	46	29	59	62	53	13	6	789,700	682,500	31,237	1,097,057	114,743
All other states[1]	5	2	3	5	4	5	4	4	1	103,000	102,500	5,889	127,322	18,254

[1] Includes states having less than 3 stations, in order that the operations of individual stations may not be disclosed. These stations are distributed as follows: Idaho, 2; Montana, 2; Rhode Island, 1.

Digitized by Google

TABLE 140.—MUNICIPAL CENTRAL ELECTRIC STATIONS—CONDENSED STATEMENT: INCOME AND EXPENSES, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	INCOME.						EXPENSES.			
		Gross income.	Electric service.				All other sources.	Total.	Salaries and wages.	Cost of supplies, materials, and fuel.	Rents, taxes, insurance, and other miscellaneous expenses.
			Total.	Lighting.	Stationary motors.	All other.					
United States	1,252	$14,011,999	$13,614,434	$13,040,263	$516,373	$57,798	$397,565	$9,167,188	$3,485,015	$4,967,687	$714,486
Alabama	28	185,576	182,216	178,674	3,292	250	3,360	121,914	42,970	72,212	6,732
Arkansas	13	122,471	121,830	120,255	392	1,183	641	87,928	31,350	50,897	5,681
California	14	290,987	284,225	229,089	52,875	2,261	6,762	168,797	63,412	96,261	9,124
Colorado	7	52,177	51,317	49,637	1,680	.....	860	31,491	12,380	17,221	1,890
Connecticut	5	163,765	163,685	144,897	18,421	367	80	88,618	33,103	43,548	11,967
Delaware	6	42,166	41,876	40,819	25	1,032	290	33,803	12,815	16,504	4,484
Florida	13	380,229	370,342	358,664	10,878	800	9,887	218,583	78,569	131,800	8,214
Georgia	59	453,495	441,826	436,106	5,220	500	11,669	272,545	111,068	146,186	15,291
Illinois	112	1,505,061	1,498,256	1,491,343	5,607	1,306	6,805	1,067,265	445,849	576,620	44,796
Indiana	68	857,499	837,887	799,749	35,939	2,199	19,612	584,293	197,221	340,902	46,170
Iowa	51	416,789	380,874	366,851	13,563	460	35,915	302,733	99,283	175,341	28,109
Kansas	32	232,228	219,928	211,634	7,356	938	12,300	157,461	67,865	77,252	12,344
Kentucky	14	179,987	177,787	163,798	13,989	.....	2,200	105,247	39,830	56,570	8,847
Louisiana	21	242,547	241,637	229,227	2,104	10,306	910	183,016	54,027	110,498	18,491
Maine	4	69,994	68,801	68,476	325	.....	1,193	32,741	19,550	7,790	5,401
Maryland	8	92,145	90,222	86,102	4,120	.....	1,923	73,645	27,926	39,905	5,814
Massachusetts	24	749,709	732,161	636,221	94,083	1,857	17,548	469,656	169,393	243,815	56,448
Michigan	104	1,233,086	1,175,934	1,140,216	30,236	5,482	57,152	790,195	319,133	405,901	65,161
Minnesota	92	771,219	718,565	685,939	30,426	2,200	52,654	552,753	180,414	328,703	43,636
Mississippi	39	328,882	318,699	308,168	5,389	5,142	10,183	218,025	80,777	115,678	21,570
Missouri	58	503,878	494,423	473,411	14,611	6,401	9,455	343,369	116,568	190,797	36,004
Nebraska	25	218,589	214,497	206,997	7,500	.....	4,092	122,016	44,875	69,356	7,785
New Hampshire	4	22,287	21,652	21,652	.....	.....	635	11,913	5,660	4,816	1,437
New Jersey	7	70,069	69,673	66,116	1,057	2,500	396	37,588	15,846	18,049	3,693
New York	47	448,462	438,840	427,338	10,903	599	9,622	300,104	126,833	150,331	22,940
North Carolina	36	313,440	307,797	296,013	11,634	150	5,643	213,491	72,054	126,722	14,715
North Dakota	8	76,742	69,974	68,572	1,384	18	6,768	68,523	22,741	39,152	6,630
Ohio	105	1,135,279	1,106,915	1,083,367	19,470	4,078	28,364	742,418	294,961	381,695	65,762
Oklahoma	14	86,371	84,801	83,562	780	459	1,570	64,411	26,946	32,628	4,837
Oregon	11	41,943	40,563	40,319	33	211	1,380	28,452	11,003	15,543	1,906
Pennsylvania	45	660,151	653,656	635,825	17,761	70	6,495	388,717	154,273	206,547	27,897
South Carolina	17	147,526	132,667	128,235	3,785	647	14,859	117,125	36,052	76,693	4,380
South Dakota	8	73,915	71,982	71,202	780	.....	1,933	57,179	18,540	33,053	5,586
Tennessee	28	287,540	274,828	254,362	19,766	700	12,712	169,610	67,513	85,573	16,524
Texas	9	207,234	207,234	191,773	14,844	617	.....	119,918	42,888	64,890	12,140
Utah	9	57,134	57,026	50,327	6,519	180	108	32,271	19,527	8,004	4,740
Vermont	13	109,418	103,916	94,401	7,216	2,299	5,502	68,893	25,590	27,353	15,950
Virginia	14	137,573	134,618	119,637	14,350	631	2,955	76,348	28,667	43,444	4,237
Washington	6	535,662	528,188	504,485	22,044	1,659	7,474	268,868	132,463	124,665	11,740
West Virginia	5	54,735	54,695	54,295	400	.....	40	46,062	20,550	24,618	894
Wisconsin	64	378,730	353,517	348,425	4,856	236	25,213	284,179	96,818	169,089	18,272
All other states[1]	5	75,309	74,904	74,084	760	60	405	45,024	17,712	21,065	6,247

[1] Includes states having less than 3 stations, in order that the operations of individual stations may not be disclosed. These stations are distributed as follows: Idaho, 2; Montana, 2; Rhode Island, 1.

Digitized by Google

TABLE 141.—MUNICIPAL CENTRAL ELECTRIC STATIONS—ANALYSIS OF

	STATE OR TERRITORY.	Number of stations.	Aggregate cost.	SUPPLIES AND MATERIALS.							
				Total cost.	Meters.		Motors.		Transformers.		Incandescent lamps.	
					Number.	Cost.	Number.	Cost.	Number.	Cost.	Number.	Cost.
1	United States	1,252	$4,967,687	$1,734,904	3,876	$48,193	124	$7,749	1,294	$49,120	771,643	$144,558
2	Alabama	28	72,212	14,323	40	432	3	320	37	1,751	7,259	1,274
3	Arkansas	13	50,897	12,082	20	282			12	493	8,849	1,574
4	California	14	96,261	55,978	7	88			2	139	12,536	2,073
5	Colorado	7	17,221	8,957							3,495	693
6	Connecticut	5	43,548	8,410	1	12			2	35	12,174	2,118
7	Delaware	6	16,504	5,082							3,790	696
8	Florida	13	131,800	24,393	8	97			2	114	6,501	1,214
9	Georgia	59	146,186	45,339	4	48			28	897	29,836	5,117
10	Illinois	112	576,620	210,045	136	1,497			100	3,570	31,241	6,804
11	Indiana	68	340,902	116,952	596	6,682	3	318	213	6,251	35,192	6,453
12	Iowa	51	175,341	62,996	234	3,068	3	180	30	1,201	37,500	7,819
13	Kansas	32	77,252	27,202	60	742			16	739	27,852	5,037
14	Kentucky	14	56,570	24,550	20	307			19	513	18,110	3,508
15	Louisiana	21	110,498	18,309	45	395			41	1,370	7,624	1,817
16	Maine	4	7,790	7,189							2,964	527
17	Maryland	8	39,905	8,032					2	56	9,780	1,353
18	Massachusetts	24	243,815	119,981	84	1,142	2	34	20	1,567	60,097	11,920
19	Michigan	104	405,901	127,602	266	2,842	6	503	59	2,377	91,400	17,016
20	Minnesota	92	328,703	91,173	232	2,922	1	85	54	1,423	41,880	8,055
21	Mississippi	39	115,678	24,784	83	1,109	25	2,062	18	525	6,165	1,164
22	Missouri	58	190,797	49,037	202	4,374			113	4,226	26,095	4,754
23	Nebraska	25	69,356	15,107	27	387			11	557	27,973	5,224
24	New Hampshire	4	4,816	4,368					1	27	3,354	974
25	New Jersey	7	18,049	4,726	57	671	3	210	14	444	1,446	430
26	New York	47	150,331	52,099	26	297			19	712	20,017	3,795
27	North Carolina	36	126,722	39,915	4	46			10	377	24,488	4,535
28	North Dakota	8	39,152	9,787	93	1,637	2	15			2,885	568
29	Ohio	105	381,695	121,083	657	7,925			169	8,285	56,891	10,263
30	Oklahoma	14	32,628	4,941	6	73			25	888	690	116
31	Oregon	11	15,543	5,980					4	180	2,600	463
32	Pennsylvania	45	206,547	84,587	171	1,938	2	158	40	1,782	34,139	5,621
33	South Carolina	17	76,693	25,810	138	1,636	24	2,310	2	76	9,071	1,679
34	South Dakota	8	33,053	13,923	10	150					3,090	542
35	Tennessee	28	85,573	25,355	16	192	9	600	28	970	19,519	3,501
36	Texas	9	64,890	10,328	2	25			9	216	7,168	1,268
37	Utah	9	8,004	5,811	12	165			21	1,127	6,935	1,357
38	Vermont	13	27,353	15,468	2	42			18	729	5,525	1,267
39	Virginia	14	43,444	22,224	124	1,496			92	2,606	9,180	1,872
40	Washington	6	124,665	121,465	300	3,150	5	300			13,930	2,153
41	West Virginia	5	24,618	14,404					1	30	310	71
42	Wisconsin	64	169,089	66,325	163	1,973	36	654	44	2,060	37,992	7,045
43	All other states[1]	5	21,065	8,782	30	371			18	807	4,100	826

[1] Includes states having less than 3 stations, in order that the operations of individual stations may not be disclosed. These stations are distributed as follows: Idaho, 2; Montana, 2; Rhode Island, 1.

Digitized by Google

SUPPLIES, MATERIALS, AND FUEL, BY STATES AND TERRITORIES: 1907.

SUPPLIES AND MATERIALS—continued.										COST OF FUEL.					
Nernst lamps, vacuum and vapor lamps, etc. (cost).	Lamp fittings, etc. (except for arc lamps) (cost).	Carbons, globes, hoods, and other supplies for arc lamps and repairs (cost).	Poles and other supports (cost).	Wire and cable (cost).	All other supplies and materials, including water for boilers, mill supplies, etc. (cost).	Power purchased.		Rent of water privileges for water wheels or turbines (cost).	Freight not included in cost of materials.	Total.	Coal.	Crude petroleum.	Natural gas.	All other fuel.	
						Electric (cost).	All other (cost).								
$3,956	$86,254	$241,278	$56,298	$146,031	$443,547	$336,332	$41,952	$35,109	$94,527	$3,232,783	$2,900,338	$128,547	$40,467	$163,431	1
.....	503	1,542	1,487	1,528	4,886	.....	.....	.....	600	57,889	49,488	.....	.....	8,401	2
.....	85	1,617	1,367	1,415	2,869	.....	2,000	.....	400	38,815	36,710	.....	.....	2,105	3
.....	1,978	3,540	1,321	4,685	4,514	37,640	.....	.....	.....	40,283	.....	33,683	.....	6,600	4
.....	173	275	77	84	953	6,702	.....	.....	.....	8,264	8,264	.....	.....	.....	5
.....	.....	1,635	995	693	2,922	.....	.....	.....	.....	35,138	27,103	3,382	.....	4,653	6
.....	18	337	45	25	1,287	578	.....	.....	2,094	11,422	11,422	.....	.....	.....	7
.....	2,023	5,106	1,143	2,121	12,442	.....	.....	.....	133	107,407	85,945	.....	.....	21,462	8
173	3,577	4,849	2,802	4,991	10,622	9,310	.....	.....	2,953	100,847	76,083	.....	.....	24,764	9
150	1,576	58,762	5,374	11,215	55,463	53,579	4,100	.....	7,955	366,575	360,045	1,800	1,800	2,930	10
230	2,212	16,474	2,941	10,217	26,067	11,244	11,600	75	16,188	223,950	221,267	.....	2,639	44	11
135	4,105	2,854	2,358	8,957	20,827	.....	1,940	.....	9,552	112,345	112,185	.....	.....	160	12
16	5,511	2,262	347	1,236	7,539	.....	1,709	900	1,164	50,050	41,965	.....	7,585	500	13
.....	1,564	5,277	340	934	11,278	.....	.....	.....	829	32,020	32,020	.....	.....	.....	14
.....	400	1,476	384	1,520	9,922	.....	984	.....	41	92,189	36,250	52,569	.....	3,370	15
.....	910	4,191	300	51	907	.....	.....	.....	303	001	001	.....	.....	.....	16
.....	80	2,337	110	260	3,586	.....	.....	.....	250	31,873	30,512	.....	.....	1,361	17
.....	1,793	5,598	4,590	16,063	18,504	39,169	.....	19,544	57	123,834	117,437	2,063	.....	4,334	18
140	10,950	29,396	7,154	11,666	32,871	7,057	2,800	625	2,205	278,299	270,103	.....	.....	8,196	19
88	4,778	6,241	2,488	8,426	31,199	6,775	.....	3,600	15,093	237,530	215,040	.....	.....	22,490	20
.....	3,773	2,205	826	1,768	7,978	2,849	.....	.....	525	90,894	87,603	.....	.....	3,291	21
751	3,731	6,315	1,695	5,448	13,324	.....	.....	.....	4,419	141,700	133,039	2,707	4,134	1,880	22
.....	1,651	1,753	432	1,066	3,074	.....	.....	.....	963	54,249	53,920	.....	.....	329	23
.....	.....	.....	18	165	384	1,300	1,500	.....	.....	448	426	.....	.....	22	24
14	55	354	335	350	1,863	.....	.....	.....	.....	13,323	13,251	.....	.....	72	25
149	2,641	6,561	923	4,312	11,693	16,867	.....	1	4,148	98,232	94,379	1,982	274	1,597	26
.....	774	4,057	735	768	9,482	9,688	9,202	.....	251	86,807	77,200	.....	.....	9,547	27
.....	103	566	573	940	3,625	.....	.....	.....	1,700	29,365	27,554	.....	.....	1,811	28
229	4,750	20,918	3,392	10,281	40,051	2,199	.....	1,715	11,075	280,612	242,638	3,443	14,528	3	29
.....	.....	737	508	159	2,460	.....	.....	.....	.....	27,687	25,587	.....	2,100	.....	30
.....	131	221	301	548	656	3,300	.....	180	.....	9,563	1,410	.....	.....	8,153	31
25	3,512	16,892	2,056	4,400	28,518	11,896	1,736	2,759	3,294	121,900	112,822	2,305	3,752	3,081	32
44	7,026	2,102	917	2,874	2,946	4,200	.....	.....	.....	50,883	46,713	.....	.....	4,120	33
45	654	760	696	619	2,242	8,215	.....	.....	.....	19,130	17,655	.....	1,135	340	34
.....	2,949	4,790	845	1,431	6,050	1,255	2,080	.....	692	60,218	59,738	.....	.....	480	35
.....	300	1,988	1,148	2,001	3,382	.....	.....	.....	.....	54,562	28,349	24,213	.....	2,000	36
.....	203	290	677	1,260	645	.....	.....	.....	87	2,193	2,193	.....	.....	.....	37
400	1,978	699	114	932	2,153	5,810	.....	1,000	284	11,885	11,885	.....	.....	.....	38
.....	105	2,669	719	3,225	4,133	2,000	.....	1,050	2,349	21,220	21,208	.....	.....	12	39
1,188	4,686	4,381	816	7,345	16,754	80,692	.....	.....	.....	3,200	400	.....	.....	2,800	40
.....	10	5,472	316	10	8,460	.....	.....	.....	35	10,214	7,694	.....	2,520	.....	41
119	4,770	3,408	1,948	9,778	12,728	11,507	2,301	3,660	4,374	102,764	89,928	400	.....	12,436	42
.....	216	371	685	264	2,288	2,500	.....	.....	454	12,283	12,196	.....	.....	87	43

Digitized by Google

TABLE 142.—MUNICIPAL CENTRAL ELECTRIC STATIONS—ANALYSIS OF INCOME, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	INCOME.										
		Gross income.	Electric service.									All other sources.
			Total.	Lighting.		Stationary motors.	Electric-railway service.	Current sold to other electric companies.	Electric heating.	Charging automobiles.	All other.	
				Commercial.	Public.							
United States	1,252	$14,011,999	$13,614,434	$7,394,987	$5,645,276	$516,373	$12,222	$6,444	$6,350	$1,288	$31,494	$397,565
Alabama	28	185,576	182,216	128,972	49,702	3,292	.....	.....	140	.....	110	3,360
Arkansas	13	122,471	121,830	72,681	47,574	392	.....	.....	.....	.....	1,183	641
California	14	290,987	284,225	155,821	73,268	52,875	.....	.....	1,080	47	1,134	6,762
Colorado	7	52,177	51,317	42,181	7,456	1,680	.....	.....	.....	.....	.....	860
Connecticut	5	163,765	163,685	103,830	41,067	18,421	.....	.....	.....	75	292	80
Delaware	6	42,166	41,876	27,761	13,058	25	1,032	.....	.....	.....	.....	290
Florida	13	380,229	370,342	292,639	66,025	10,878	800	.....	.....	.....	.....	9,887
Georgia	59	453,495	441,826	280,349	155,757	5,220	.....	.....	.....	.....	500	11,669
Illinois	112	1,505,061	1,498,256	350,908	1,140,435	5,607	.....	1,170	100	.....	36	6,805
Indiana	68	857,499	837,887	531,682	268,067	35,939	1,500	.....	341	283	75	19,612
Iowa	51	416,789	380,874	268,746	98,105	13,563	.....	.....	20	160	280	35,915
Kansas	32	232,228	219,928	128,217	83,417	7,356	300	.....	30	6	602	12,300
Kentucky	14	179,987	177,787	86,977	76,821	13,989	.....	.....	.....	.....	.....	2,200
Louisiana	21	242,547	241,637	163,530	65,697	2,104	.....	.....	336	.....	9,970	910
Maine	4	69,994	68,801	7,404	61,072	325	.....	.....	.....	.....	.....	1,193
Maryland	8	92,145	90,222	28,523	57,579	4,120	.....	.....	.....	.....	.....	1,923
Massachusetts	24	749,709	732,161	373,513	262,708	94,083	.....	108	340	313	1,096	17,548
Michigan	104	1,233,086	1,175,934	586,227	553,989	30,236	.....	1,677	220	179	3,406	57,152
Minnesota	92	771,219	718,565	518,638	167,301	30,426	.....	.....	1,141	55	1,004	52,654
Mississippi	39	328,882	318,699	238,113	70,055	5,389	.....	.....	48	.....	5,094	10,183
Missouri	58	503,878	494,423	289,480	184,931	14,611	6,090	.....	.....	.....	311	9,455
Nebraska	25	218,589	214,497	132,144	74,853	7,500	.....	.....	.....	.....	.....	4,092
New Hampshire	4	22,287	21,652	15,168	6,484	.....	.....	.....	.....	.....	.....	635
New Jersey	7	70,069	69,673	40,225	25,891	1,057	2,500	.....	.....	.....	.....	396
New York	47	448,462	438,840	225,170	202,168	10,903	.....	.....	57	92	450	9,622
North Carolina	36	313,440	307,797	201,663	94,350	11,634	.....	.....	70	.....	80	5,643
North Dakota	8	76,742	69,974	50,660	17,912	1,384	.....	.....	.....	18	.....	6,768
Ohio	105	1,135,279	1,106,915	551,749	531,618	19,470	.....	.....	1,375	.....	2,703	28,364
Oklahoma	14	86,371	84,801	56,650	26,912	780	.....	.....	.....	.....	459	1,570
Oregon	11	41,943	40,563	32,038	8,281	33	.....	.....	146	.....	65	1,380
Pennsylvania	45	660,151	653,656	202,157	433,668	17,761	.....	.....	10	60	.....	6,495
South Carolina	17	147,526	132,667	77,907	50,328	3,785	.....	.....	647	.....	.....	14,859
South Dakota	8	73,915	71,982	47,711	23,491	780	.....	.....	.....	.....	.....	1,933
Tennessee	28	287,540	274,828	109,944	144,418	19,766	.....	700	.....	.....	.....	12,712
Texas	9	207,234	207,234	111,690	80,083	14,844	.....	.....	.....	.....	617	.....
Utah	9	57,134	57,026	40,659	9,668	6,519	.....	180	.....	.....	.....	108
Vermont	13	109,418	103,916	64,095	30,306	7,216	.....	950	.....	.....	1,349	5,502
Virginia	14	137,573	134,618	69,816	49,821	14,350	.....	.....	100	.....	531	2,955
Washington	6	535,662	528,188	391,389	113,096	22,044	.....	1,659	.....	.....	.....	7,474
West Virginia	5	54,735	54,695	6,838	47,457	400	.....	.....	.....	.....	.....	40
Wisconsin	64	378,730	353,517	239,681	108,744	4,856	.....	.....	89	.....	147	25,213
All other states[1]	5	75,309	74,904	52,441	21,643	760	.....	.....	60	.....	.....	405

[1] Includes states having less than 3 stations, in order that the operations of individual stations may not be disclosed. These stations are distributed as follows: Idaho, 2; Montana, 2; Rhode Island, 1.

Digitized by Google

TABLE 143.—MUNICIPAL CENTRAL ELECTRIC STATIONS—NUMBER OF SALARIED EMPLOYEES AND TOTAL SALARIES, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	TOTAL.		GENERAL MANAGERS, SUPERINTENDENTS, ETC.		CLERKS AND BOOKKEEPERS.	
		Number.	Salaries.	Number.	Salaries.	Number.	Salaries.
United States	1,252	1,615	$994,832	1,089	$814,929	526	$179,903
Alabama	28	27	17,915	25	17,705	2	210
Arkansas	13	15	11,600	11	9,530	4	2,070
California	14	27	21,208	13	14,655	14	6,553
Colorado	7	9	5,630	5	4,250	4	1,380
Connecticut	5	10	9,010	5	6,270	5	2,740
Delaware	6	12	4,929	10	4,149	2	780
Florida	13	26	21,550	12	11,620	14	9,930
Georgia	59	78	50,775	64	46,775	14	4,000
Illinois	112	73	52,623	54	45,480	19	7,143
Indiana	68	93	55,309	68	46,741	25	8,568
Iowa	51	53	30,170	33	25,728	20	4,442
Kansas	32	43	22,165	29	19,826	14	2,339
Kentucky	14	16	11,300	11	9,980	5	1,320
Louisiana	21	32	23,644	21	20,580	11	3,064
Maine	4	6	3,082	6	3,082	.....	.....
Maryland	8	6	2,970	3	2,580	3	390
Massachusetts	24	60	40,248	36	29,437	24	10,811
Michigan	104	176	100,823	104	81,735	72	19,088
Minnesota	92	97	74,905	67	63,541	30	11,364
Mississippi	39	56	34,878	40	29,329	16	5,549
Missouri	58	59	37,363	41	33,150	18	4,213
Nebraska	25	23	13,554	15	11,930	8	1,624
New Hampshire	4	5	2,650	2	2,300	3	350
New Jersey	7	7	4,050	3	2,540	4	1,510
New York	47	58	29,769	32	23,642	26	6,127
North Carolina	36	40	30,187	32	27,747	8	2,440
North Dakota	8	10	10,307	8	9,272	2	1,035
Ohio	105	206	75,305	134	56,606	72	18,699
Oklahoma	14	19	9,112	13	7,920	6	1,192
Oregon	11	6	2,995	5	2,795	1	200
Pennsylvania	45	45	28,437	32	23,814	13	5,123
South Carolina	17	21	15,000	17	13,280	4	1,720
South Dakota	8	7	7,540	7	7,540	.....	.....
Tennessee	28	35	21,783	30	20,851	5	932
Texas	9	17	13,042	8	6,540	9	6,502
Utah	9	9	7,173	7	6,033	2	1,140
Vermont	13	20	9,061	16	8,328	4	733
Virginia	14	15	7,135	11	6,470	4	665
Washington	6	31	34,455	11	14,765	20	19,690
West Virginia	5	4	1,720	2	1,360	2	360
Wisconsin	64	54	31,534	40	29,003	14	2,531
All other states[1]	5	9	7,926	6	6,550	3	1,376

[1] Includes states having less than 3 stations, in order that the operations of individual stations may not be disclosed. These stations are distributed as follows: Idaho, 2; Montana, 2; Rhode Island, 1.

Digitized by Google

TABLE 144.—MUNICIPAL CENTRAL ELECTRIC STATIONS—AVERAGE NUMBER OF WAGE-EARNERS AND TOTAL WAGES, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	TOTAL.		FOREMEN.		INSPECTORS.		ENGINEERS.		ALL OTHER EMPLOYEES (INCLUDING FIREMEN, DYNAMO AND SWITCHBOARD MEN, LINEMEN, MECHANICS, AND LAMP TRIMMERS).	
		Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
United States	1,252	3,951	$2,490,183	90	$81,446	34	$28,632	1,411	$969,147	2,416	$1,410,958
Alabama	28	67	25,055					27	11,125	40	13,930
Arkansas	13	31	19,750	1	1,000	1	480	14	9,640	15	8,630
California	14	58	42,204	3	3,436			19	16,547	36	22,221
Colorado	7	10	6,750					6	3,840	4	2,910
Connecticut	5	32	24,093	1	884	1	728	10	9,198	20	13,283
Delaware	6	15	7,886					8	4,940	7	2,946
Florida	13	104	57,019	1	1,200	6	4,387	20	13,182	77	38,250
Georgia	59	137	60,293	4	2,380			43	23,181	90	34,732
Illinois	112	475	393,226	14	14,055	2	2,280	137	111,961	322	264,930
Indiana	68	239	141,912	3	2,630	3	2,160	89	57,632	144	79,490
Iowa	51	113	69,113	2	1,510			61	41,195	50	26,408
Kansas	32	89	45,700	2	1,080			44	26,136	43	18,484
Kentucky	14	48	28,530	1	900			18	12,290	29	15,340
Louisiana	21	65	30,383					25	15,689	40	14,694
Maine	4	23	16,468	1	300			3	2,616	19	13,552
Maryland	8	37	24,956					11	8,883	26	16,073
Massachusetts	24	164	129,145	6	6,242	3	2,707	51	46,607	104	73,589
Michigan	104	398	218,310	8	4,637	2	2,250	138	81,943	250	129,480
Minnesota	92	178	105,509	2	1,440			96	63,839	80	40,230
Mississippi	39	105	45,899	3	2,340			42	21,022	60	22,537
Missouri	58	127	79,205	5	4,620	1	960	51	36,513	70	37,112
Nebraska	25	50	31,321					22	15,014	28	16,307
New Hampshire	4	5	3,010							5	3,010
New Jersey	7	22	11,796	1	832	1	624	7	4,152	13	6,188
New York	47	158	97,064	4	3,469			55	35,835	99	57,760
North Carolina	36	91	41,867	3	2,250			28	14,091	60	24,926
North Dakota	8	16	12,434					9	7,766	7	4,668
Ohio	105	337	219,656	8	7,615	3	2,235	141	106,316	185	103,490
Oklahoma	14	31	17,834					18	11,734	13	6,100
Oregon	11	15	8,008					8	5,215	7	2,793
Pennsylvania	45	167	125,836	5	5,516	4	3,141	53	42,249	105	74,930
South Carolina	17	49	21,052					16	9,640	33	11,412
South Dakota	8	18	11,000	1	330			8	5,720	9	4,950
Tennessee	28	84	45,730					29	17,705	55	28,025
Texas	9	45	29,846	1	1,200	1	900	15	10,566	28	17,180
Utah	9	18	12,354					3	2,569	15	9,785
Vermont	13	28	16,529					2	1,837	26	14,692
Virginia	14	34	21,532			2	1,540	13	9,750	19	10,242
Washington	6	110	98,008	8	9,780	3	3,240	3	2,280	96	82,708
West Virginia	5	29	18,830	1	720			7	5,284	21	12,826
Wisconsin	64	114	65,284	1	1,080			56	38,725	57	25,479
All other states[1]	5	15	9,786			1	1,000	5	4,120	9	4,666

[1] Includes states having less than 3 stations, in order that the operations of individual stations may not be disclosed. These stations are distributed as follows: Idaho, 2; Montana, 2; Rhode Island, 1.

Digitized by Google

TABLE 145.—MUNICIPAL CENTRAL ELECTRIC STATIONS—ANALYSIS OF MISCELLANEOUS EXPENSES, BY STATES AND TERRITORIES: 1907.

STATE OR TERRITORY.	Number of stations.	Total expenses.	Rent of stations, line-wire supports, conduits, etc.	Rent of offices.	Taxes.	Injuries and damages.	Insurance.	Ordinary repairs of buildings and machinery.	All other expenses.
United States	1,252	$714,486	$5,654	$10,721	$5,224	$32,468	$110,269	$314,098	$236,052
Alabama	28	6,732	.....	168	.....	.....	885	2,519	3,160
Arkansas	13	5,681	.....	130	150	.....	1,069	2,561	1,771
California	14	9,124	.....	.....	.....	.....	1,578	2,452	5,094
Colorado	7	1,890	96	.....	.....	.....	314	250	1,230
Connecticut	5	11,967	.....	30	.....	.....	1,958	6,527	3,452
Delaware	6	4,484	.....	145	159	.....	326	2,322	1,532
Florida	13	8,214	.....	46	117	.....	4,746	2,238	1,067
Georgia	59	15,291	.....	243	.....	662	3,635	5,001	5,750
Illinois	112	44,796	875	133	.....	2,700	6,259	22,144	12,685
Indiana	68	46,170	.....	1,241	508	25	7,737	19,629	17,030
Iowa	51	28,109	.....	168	.....	1,830	4,592	9,493	12,026
Kansas	32	12,344	.....	270	.....	.....	1,895	5,945	4,234
Kentucky	14	8,847	333	192	20	.....	1,737	3,123	3,442
Louisiana	21	18,491	.....	.....	50	25	1,775	14,781	1,860
Maine	4	5,401	.....	.....	.....	.....	483	2,602	2,316
Maryland	8	5,814	.....	120	.....	625	576	3,506	987
Massachusetts	24	56,448	386	628	6	.....	9,802	23,755	21,871
Michigan	104	65,161	175	676	127	2,992	7,646	33,783	19,762
Minnesota	92	43,636	189	402	170	1,685	8,659	24,187	8,344
Mississippi	39	21,570	120	65	.....	11,100	3,003	4,096	3,186
Missouri	58	36,004	.....	540	700	3,300	5,708	14,330	11,426
Nebraska	25	7,785	.....	256	160	.....	840	3,673	2,856
New Hampshire	4	1,437	.....	96	.....	.....	251	243	847
New Jersey	7	3,693	.....	540	53	.....	872	852	1,376
New York	47	22,940	26	206	414	.....	4,479	9,832	7,983
North Carolina	36	14,715	.....	699	100	1,130	2,319	4,516	5,951
North Dakota	8	6,630	.....	225	200	.....	1,056	3,718	1,431
Ohio	105	65,762	63	670	.....	3,315	8,003	31,390	22,321
Oklahoma	14	4,837	.....	172	.....	40	606	2,008	2,011
Oregon	11	1,906	.....	.....	.....	.....	241	665	1,000
Pennsylvania	45	27,897	327	18	403	15	2,961	15,226	8,947
South Carolina	17	4,380	.....	183	30	286	1,083	1,588	1,210
South Dakota	8	5,586	.....	.....	16	.....	421	1,516	3,633
Tennessee	28	16,524	1,320	170	50	2,000	1,872	6,565	4,547
Texas	9	12,140	.....	600	.....	308	2,592	6,464	2,176
Utah	9	4,740	.....	300	.....	.....	105	3,372	963
Vermont	13	15,950	612	411	650	.....	2,165	4,018	8,094
Virginia	14	4,237	120	280	920	.....	1,045	1,258	614
Washington	6	11,740	1,000	500	.....	.....	406	820	9,014
West Virginia	5	894	.....	.....	.....	.....	102	467	325
Wisconsin	64	18,272	12	18	46	80	3,801	7,805	6,510
All other states [1]	5	6,247	.....	180	175	350	666	2,858	2,018

[1] Includes states having less than 3 stations, in order that the operations of individual stations may not be disclosed. These stations are distributed as follows: Idaho, 2; Montana, 2; Rhode Island, 1.

Digitized by Google

TABLE 146.—CENTRAL ELECTRIC LIGHT AND POWER STATIONS OPERATED BY STREET-RAILWAY COMPANIES—ANALYSIS OF ARC-LIGHTING SERVICE, BY STATES: 1907[1] AND 1902.

[Separate reports for these stations could not be secured, hence the statistics for them have been included with those for electric railways.]

STATE OR TERRITORY.	Census.	Number of companies.	ARC LIGHTING—NUMBER OF LAMPS WIRED FOR SERVICE.														
			Aggregate.	Total.				Direct-current.				Alternating-current.				All other.[2]		
				Commercial.		Public.		Commercial.		Public.		Commercial.		Public.		Commercial.		Public (open).
				Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	Open.	Inclosed.	
Total	1907	177	80,102	4,491	46,183	4,644	24,784	882	11,013	4,504	6,220	3,609	35,170	140	18,564	.....	.....	.....
	1902	118	33,863	2,582	13,603	10,868	6,810	2,413	6,459	10,495	1,072	1	7,069	8	5,738	168	75	365
Alabama	1907	5	2,633	.....	1,759	.....	874	.....	1,015	.....	.....	.....	744	.....	874	.....	.....	.....
	1902	4	1,291	449	442	325	75	449	388	325	.....	.....	54	.....	75	.....	.....	.....
Arkansas[3]	1907	5	1,527	.....	1,368	.....	159	.....	350	.....	.....	.....	1,018	.....	159	.....	.....	.....
Florida	1907	5	745	109	287	.....	349	109	.....	.....	.....	.....	287	.....	349	.....	.....	.....
	1902	3	222	103	55	.....	64	103	.....	.....	.....	.....	55	.....	64	.....	.....	.....
Georgia	1907	7	6,172	164	3,308	727	1,973	161	1,655	707	239	3	1,653	20	1,734	.....	.....	.....
	1902	7	4,347	238	2,092	761	1,256	238	1,294	761	238	.....	798	.....	1,018	.....	.....	.....
Illinois	1907	12	4,099	103	2,447	278	1,271	.....	1,141	278	640	103	1,306	.....	631	.....	.....	.....
	1902	4	817	235	328	.....	254	235	295	.....	254	.....	33	.....	.....	.....	.....	.....
Indiana[3]	1907	7	2,133	.....	1,196	74	863	.....	.....	74	661	.....	1,196	.....	202	.....	.....	.....
Iowa	1907	11	2,886	38	1,219	234	1,395	30	140	234	51	8	1,079	.....	1,344	.....	.....	.....
	1902	8	1,603	133	388	812	270	133	84	812	40	.....	304	.....	230	.....	.....	.....
Kansas[3]	1907	3	483	39	53	93	298	39	5	93	.....	.....	48	.....	298	.....	.....	.....
Maine	1907	3	658	.....	454	104	100	.....	101	104	52	.....	353	.....	48	.....	.....	.....
	1902	3	431	25	230	115	61	25	115	115	30	.....	115	.....	31	.....	.....	.....
Michigan	1907	7	1,308	.....	590	89	629	.....	.....	89	.....	.....	590	.....	629	.....	.....	.....
	1902	6	869	30	286	352	201	30	36	352	.....	.....	250	.....	201	.....	.....	.....
Mississippi	1907	6	899	.....	254	.....	645	.....	.....	.....	.....	.....	254	.....	645	.....	.....	.....
	1902	3	477	.....	112	132	233	.....	.....	132	.....	.....	112	.....	233	.....	.....	.....
Missouri	1907	4	1,079	.....	890	.....	189	.....	.....	.....	.....	.....	890	.....	189	.....	.....	.....
	1902	3	203	37	5	111	50	37	.....	111	.....	.....	5	.....	50	.....	.....	.....
New York	1907	11	2,566	759	306	163	1,338	.....	31	163	400	759	275	.....	938	.....	.....	.....
	1902	10	2,594	56	1,070	964	504	55	65	964	.....	1	1,005	.....	504	.....	.....	.....
North Carolina	1907	8	1,821	.....	837	194	790	.....	.....	194	.....	.....	837	.....	790	.....	.....	.....
	1902	5	613	12	174	325	102	12	.....	325	.....	.....	174	.....	102	.....	.....	.....
Ohio	1907	20	7,152	.....	2,659	359	4,134	.....	1,298	249	2,555	.....	1,361	110	1,579	.....	.....	.....
	1902	11	2,933	24	518	1,838	553	24	90	1,838	.....	.....	353	.....	553	.....	75	.....
Pennsylvania[4]	1907	7	619	.....	338	14	267	.....	12	14	.....	.....	326	.....	267	.....	.....	.....
South Carolina	1907	3	1,114	.....	432	.....	682	.....	.....	.....	275	.....	432	.....	407	.....	.....	.....
	1902	3	693	.....	236	.....	457	.....	37	.....	198	.....	199	.....	259	.....	.....	.....
Tennessee[3]	1907	3	3,914	2,765	809	.....	340	62	.....	.....	.....	2,703	809	.....	340	.....	.....	.....
Texas[4]	1907	4	540	7	299	.....	234	.....	12	.....	.....	7	287	.....	234	.....	.....	.....
Virginia	1907	10	5,956	42	3,305	483	2,126	42	1,913	483	270	.....	1,392	.....	1,856	.....	.....	.....
	1902	7	2,983	219	1,710	757	297	219	933	757	100	.....	777	.....	197	.....	.....	.....
Washington	1907	6	3,340	.....	2,932	.....	408	.....	1,474	.....	.....	.....	1,458	.....	408	.....	.....	.....
	1902	4	1,854	116	1,416	19	303	116	1,263	19	121	.....	153	.....	182	.....	.....	.....
West Virginia	1907	7	1,259	.....	325	.....	934	.....	.....	.....	34	.....	325	.....	900	.....	.....	.....
	1902	3	572	.....	70	75	427	.....	.....	75	.....	.....	70	.....	427	.....	.....	.....
Wisconsin	1907	7	5,391	420	1,773	1,348	1,850	420	1,057	1,348	15	.....	716	.....	1,835	.....	.....	.....
	1902	9	4,715	387	1,778	1,871	679	387	1,277	1,871	91	.....	501	.....	588	.....	.....	.....
All other states[5]	1907	16	21,808	45	18,343	484	2,936	19	809	474	1,028	26	17,534	10	1,908	.....	.....	.....
	1902	25	6,646	518	2,693	2,411	1,024	350	582	2,038	.....	.....	2,111	8	1,024	168	.....	365

[1] Two companies in one of the outlying districts (Porto Rico) reported light plants, which have been excluded from this table.
[2] Not reported in 1907.
[3] Included in "All other states" in 1902.
[4] No report for 1902.
[5] Includes states having less than 3 companies, in order that the operations of individual companies may not be disclosed. These companies are distributed as follows: In 1907—California, 1; Colorado, 2; Connecticut, 1; Kentucky, 2; Louisiana, 2; Maryland, 1; Massachusetts, 1; Minnesota, 1; Montana, 1; Nebraska, 1; New Hampshire, 1; New Mexico, 1; Utah, 1; in 1902—Arkansas, 2; California, 2; Colorado, 2; Connecticut, 2; Delaware, 1; Indiana, 2; Kansas, 1; Kentucky, 2; Louisiana, 1; Maryland, 1; Minnesota, 1; Montana, 1; Nebraska, 1; New Hampshire, 1; New Jersey, 2; Oregon, 1; Tennessee, 2.

Digitized by Google

TABLE 147.—CENTRAL ELECTRIC LIGHT AND POWER STATIONS OPERATED BY STREET-RAILWAY COMPANIES—ANALYSIS OF INCANDESCENT AND OTHER VARIETIES OF LIGHTING SERVICE AS WELL AS MOTOR SERVICE AND NUMBER OF METERS, BY STATES: 1907[1] AND 1902.

[Separate reports for these stations could not be secured, hence the statistics for them have been included with those for electric railways.]

STATE OR TERRITORY.	Census.	Number of companies.	INCANDESCENT LIGHTING—NUMBER OF LAMPS WIRED FOR SERVICE.									OTHER ELECTRIC LIGHTING[2] (NERNST, VACUUM, VAPOR, ETC.)—NUMBER OF LAMPS WIRED FOR SERVICE.			STATIONARY-MOTOR SERVICE.		Number of meters on consumption circuits.
			Aggregate.	Total.		16-candlepower.		32-candlepower.		All other.					Number of motors.	Total capacity in horsepower.	
				Commercial.	Public.	Commercial.	Public.	Commercial.	Public.	Commercial.	Public.	Total.	Commercial.	Public.			
Total	1907	177	4,545,839	4,487,681	58,158	3,871,786	48,451	217,228	2,264	398,667	7,443	28,641	28,267	374	20,468	158,923	213,886
	1902	118	1,442,685	1,423,659	19,026	1,313,303	13,065	31,597	1,119	78,759	4,842	.....	.....	.....	10,049	35,688	56,601
Alabama	1907	5	151,108	151,003	105	150,648	105	355	.....	.....	.....	.....	.....	.....	989	4,923	9,331
	1902	4	50,704	50,045	659	47,705	659	2,203	.....	137	.....	.....	.....	.....	648	936	2,606
Arkansas[3]	1907	5	88,897	88,404	493	78,219	.....	1,362	131	8,823	362	1	1	.....	898	2,420	6,305
Florida	1907	5	83,066	81,790	1,276	81,165	1,235	250	.....	375	41	71	71	.....	580	2,624	5,404
	1902	3	19,872	19,541	331	19,408	323	127	8	6	.....	.....	.....	.....	137	714	880
Georgia	1907	7	322,843	320,761	2,082	313,261	1,536	7,500	.....	.....	546	167	167	.....	1,853	14,377	12,572
	1902	7	136,978	135,604	1,374	132,630	900	1,470	30	1,504	444	.....	.....	.....	2,066	4,844	5,121
Illinois	1907	12	270,367	270,193	174	238,140	100	7,837	54	24,216	20	391	114	277	1,490	5,952	10,862
	1902	4	42,426	42,426	.....	37,883	.....	226	.....	4,317	.....	.....	.....	.....	202	611	1,475
Indiana[3]	1907	7	91,304	91,178	126	72,989	106	4,473	.....	13,716	20	80	80	.....	473	2,123	4,842
Iowa	1907	11	150,693	150,289	404	114,592	245	6,620	159	29,077	.....	2,838	2,832	6	947	5,408	7,356
	1902	8	62,284	61,924	360	57,610	60	1,830	50	2,484	250	.....	.....	.....	549	1,479	3,338
Kansas[3]	1907	3	36,000	29,000	7,000	5,200	6,500	22,300	150	1,500	350	65	65	.....	164	1,491	1,787
Maine	1907	3	82,363	82,036	327	60,974	238	7,854	75	13,208	14	.....	.....	.....	283	2,279	2,353
	1902	3	39,443	39,379	64	38,079	.....	300	39	1,000	25	.....	.....	.....	129	1,011	1,139
Michigan	1907	7	103,462	100,902	2,560	92,740	2,371	2,550	85	5,612	104	202	202	.....	527	3,277	5,360
	1902	6	43,389	41,169	2,220	36,577	2,130	1,134	90	3,458	.....	.....	.....	.....	136	700	1,857
Mississippi	1907	6	66,240	65,620	620	58,920	405	5,000	215	1,700	.....	204	148	56	151	1,065	4,160
	1902	3	12,887	11,890	997	11,290	997	100	.....	500	.....	.....	.....	.....	295	198	714
Missouri	1907	4	88,930	88,820	110	65,999	60	22,578	.....	243	50	22	22	.....	392	2,621	3,966
	1902	3	66,130	66,075	55	45,000	50	75	5	21,000	.....	.....	.....	.....	87	119	1,553
New York	1907	11	134,363	124,273	10,090	119,697	5,051	1,451	21	3,125	5,018	.....	.....	.....	482	5,446	5,434
	1902	10	100,561	98,812	1,749	86,950	691	2,257	47	9,605	1,011	.....	.....	.....	336	2,662	6,217
North Carolina	1907	8	126,131	124,681	1,450	102,882	1,450	3,697	.....	18,102	.....	380	380	.....	556	5,043	6,562
	1902	5	31,742	31,498	244	28,132	204	423	40	2,943	.....	.....	.....	.....	105	1,544	1,273
Ohio	1907	20	522,022	516,469	5,553	386,692	5,198	32,705	150	97,072	205	1,335	1,300	35	2,275	17,613	19,211
	1902	11	189,708	188,065	1,643	186,683	1,613	682	20	700	10	.....	.....	.....	513	3,589	5,813
Pennsylvania[4]	1907	7	31,331	31,057	274	25,988	150	564	116	4,505	8	169	169	.....	70	451	1,251
South Carolina	1907	3	115,767	110,370	5,397	101,370	5,391	6,000	6	3,000	.....	.....	.....	.....	339	7,598	3,629
	1902	3	24,225	24,117	108	23,517	100	600	.....	.....	8	.....	.....	.....	689	618	1,270
Tennessee[3]	1907	3	191,491	191,491	.....	177,439	.....	3,759	.....	10,293	.....	31	31	.....	801	10,083	9,288
Texas[4]	1907	4	82,656	80,811	1,845	80,811	1,845	.....	.....	.....	.....	9,251	9,251	.....	275	3,349	5,729
Virginia	1907	10	373,928	372,713	1,215	284,321	849	7,030	230	81,362	136	22	22	.....	894	15,416	15,553
	1902	7	65,148	64,815	333	52,595	328	2,224	5	9,996	.....	.....	.....	.....	1,960	1,467	3,100
Washington	1907	6	293,672	292,068	1,604	276,518	1,564	1,635	40	13,915	.....	566	566	.....	1,614	12,861	22,181
	1902	4	93,247	90,483	2,764	70,667	205	10,828	35	8,988	2,524	.....	.....	.....	587	3,720	4,838
West Virginia	1907	7	88,967	78,571	10,396	68,662	10,005	4,459	391	5,450	.....	187	187	.....	153	857	4,171
	1902	3	23,294	23,294	.....	20,984	.....	1,647	.....	663	.....	.....	.....	.....	28	121	770
Wisconsin	1907	7	382,724	382,278	446	381,278	396	.....	50	1,000	.....	11,108	11,108	.....	1,914	13,121	12,708
	1902	9	180,073	179,611	462	170,305	337	3,646	125	5,660	.....	.....	.....	.....	87	3,711	5,403
All other states[5]	1907	16	667,514	662,903	4,611	533,281	3,651	67,249	391	62,373	569	1,551	1,551	.....	2,348	18,525	33,871
	1902	25	260,574	254,911	5,663	247,288	4,468	1,825	625	5,798	570	.....	.....	.....	1,495	7,644	9,234

[1] Two companies in one of the outlying districts (Porto Rico) reported light plants, which have been excluded from this table.
[2] Not reported in 1902.
[3] Included in "All other states" in 1902.
[4] No report for 1902.
[5] Includes states having less than 3 companies, in order that the operations of individual companies may not be disclosed. These companies are distributed as follows: In 1907—California, 1; Colorado, 2; Connecticut, 1; Kentucky, 2; Louisiana, 2; Maryland, 1; Massachusetts, 1; Minnesota, 1; Montana, 1; Nebraska, 1; New Hampshire, 1; New Mexico, 1; Utah, 1; in 1902—Arkansas, 2; California, 2; Colorado, 2; Connecticut, 2; Delaware, 1; Indiana, 2; Kansas, 1; Kentucky, 2; Louisiana, 1; Maryland, 1; Minnesota, 1; Montana, 1; Nebraska, 1; New Hampshire, 1; New Jersey, 2; Oregon, 1; Tennessee, 2.

Digitized by Google

TABLE 148.—CENTRAL ELECTRIC LIGHT AND POWER STATIONS OPERATED BY STREET-RAILWAY COMPANIES—INCOME, BY STATES: 1907 [1] AND 1902.

[Separate reports for these stations could not be secured, hence the statistics for them have been included with those for electric railways.]

STATE OR TERRITORY.	Census.	Number of companies.	INCOME.					
			Gross income.	From sale of current.				From all other sources.
				Total.	Lighting.	Stationary motors.	All other electric service.	
Total	1907	177	$17,291,824	$16,576,555	$13,273,295	$2,685,013	$618,247	$715,269
	1902	118	6,469,726	6,271,815	5,492,669	768,040	11,106	197,911
Alabama	1907	5	671,425	671,425	586,629	84,796	.....	.....
	1902	4	318,660	317,011	290,166	26,345	500	1,649
Arkansas [2]	1907	5	383,631	383,225	340,524	39,529	3,172	406
Florida	1907	5	380,022	375,691	326,207	49,427	57	4,331
	1902	3	110,209	110,209	96,557	13,652	.....	.....
Georgia	1907	7	1,498,822	1,484,966	1,169,744	284,938	30,284	13,856
	1902	7	722,728	713,700	594,207	119,260	233	9,028
Illinois	1907	12	943,859	829,667	685,299	106,664	37,704	114,192
	1902	4	161,070	151,867	125,078	23,038	3,751	9,203
Indiana [2]	1907	7	331,342	315,220	270,510	43,710	1,000	16,122
Iowa	1907	11	594,884	540,986	428,788	103,091	9,107	53,898
	1902	8	291,142	270,423	230,380	40,043	.....	20,719
Kansas [2]	1907	3	146,669	131,954	104,850	27,074	30	14,715
Maine	1907	3	188,456	187,237	155,637	29,618	1,982	1,219
	1902	3	101,892	94,736	79,595	15,141	.....	7,156
Michigan	1907	7	345,813	321,768	256,329	30,778	34,661	24,045
	1902	6	162,549	157,920	148,580	9,340	.....	4,629
Mississippi	1907	6	317,855	308,053	292,353	15,400	300	9,802
	1902	3	98,838	98,838	89,779	8,982	77	.....
Missouri	1907	4	274,929	240,957	195,105	45,852	.....	33,972
	1902	3	163,406	151,004	148,764	2,240	.....	12,402
New York	1907	11	621,856	612,683	532,373	74,058	6,252	9,173
	1902	10	413,782	412,403	384,231	28,172	.....	1,379
North Carolina	1907	8	491,081	473,651	389,632	81,282	2,737	17,430
	1902	5	155,770	155,770	119,405	36,365	.....	.....
Ohio	1907	20	1,597,195	1,461,559	1,184,555	210,712	66,292	135,636
	1902	11	587,967	574,929	521,547	53,382	.....	13,038
Pennsylvania [2]	1907	7	104,703	102,878	93,446	9,422	10	1,825
South Carolina	1907	3	438,911	437,483	272,293	164,156	1,034	1,428
	1902	3	171,561	155,248	133,121	22,127	.....	16,313
Tennessee [2]	1907	3	700,100	700,100	534,804	146,798	18,498	.....
Texas [3]	1907	4	484,860	484,128	391,070	93,058	.....	732
Virginia	1907	10	1,444,593	1,434,429	1,122,482	172,207	139,740	10,164
	1902	7	359,158	355,600	327,200	28,400	.....	3,558
Washington	1907	6	1,295,428	1,135,051	898,397	221,085	15,569	160,377
	1902	4	618,385	562,332	483,902	76,635	1,795	56,053
West Virginia	1907	7	326,752	323,434	282,923	9,102	31,409	3,318
	1902	3	105,102	105,102	103,434	1,668	.....	.....
Wisconsin	1907	7	1,024,621	962,315	766,039	194,135	2,141	62,306
	1902	9	689,572	662,983	585,817	77,166	.....	26,589
All other states [4]	1907	16	2,684,017	2,657,695	1,993,306	448,121	216,268	26,322
	1902	25	1,237,935	1,221,740	1,030,906	186,084	4,750	16,195

[1] Two companies in one of the outlying districts (Porto Rico) reported light plants, which have been excluded from this table.
[2] Included in "All other states" in 1902.
[3] No report for 1902.
[4] Includes states having less than 3 companies, in order that the operations of individual companies may not be disclosed. These companies are distributed as follows: In 1907—California, 1; Colorado, 2; Connecticut, 1; Kentucky, 2; Louisiana, 2; Maryland, 1; Massachusetts, 1; Minnesota, 1; Montana, 1; Nebraska, 1; New Hampshire, 1; New Mexico, 1; Utah, 1; in 1902—Arkansas, 2; California, 2; Colorado, 2; Connecticut, 2; Delaware, 1; Indiana, 2; Kansas, 1; Kentucky, 2; Louisiana, 1; Maryland, 1; Minnesota, 1; Montana, 1; Nebraska, 1; New Hampshire, 1; New Jersey, 2; Oregon, 1; Tennessee, 2.

Digitized by Google

APPENDICES

APPENDIX A.—SCHEDULE

APPENDIX B.—INSTRUCTIONS TO SPECIAL AGENTS

Digitized by Google

Digitized by Google

APPENDIX A.

SCHEDULE.

Name of company or plant.....
Location of plant: {State..... County.....
{City or town..... Street and No.....
General Office (give state, city, street, and number).....

WASHINGTON, D. C., *December 31, 1907.*

The act of Congress of June 7, 1906, directs the Director of the Census to take a census of electric light and power stations every five years, and this schedule has been formulated for that purpose.

The information returned on this schedule should cover the business year of the company most nearly conforming to the year ending December 31, 1907. All questions that require a fixed time, such as cash on hand, number of lamps, etc., should be of the date of the last day of the year covered by the report.

The answers to inquiries in regard to financial matters will be held absolutely confidential; the separate reports will be combined so as to show totals for all companies in the different states. No publication will be made in the census reports disclosing the operations of individual companies. The information will be used only for the statistical purposes for which it is given.

The canvass is to be made under the supervision of Mr. W. M. Steuart, Chief Statistician for Manufactures.

S. N. D. NORTH,
Director of the Census.

Extract from act of Congress, March 3, 1899:

Section 22. * * * "And every president, treasurer, secretary, director, agent, or other officer of every corporation, and every establishment of productive industry, whether conducted as a corporate body, limited liability company, or by private individuals, from which answers to any of the schedules, inquiries, or statistical interrogatories provided for by this act are herein required, who shall, if thereto requested by the Director, supervisor, enumerator, or special agent, willfully neglect or refuse to give true and complete answers to any inquiries authorized by this act, or shall willfully give false information, shall be guilty of a misdemeanor, and upon conviction thereof shall be fined not exceeding ten thousand dollars, to which may be added imprisonment for a period not exceeding one year."

CERTIFICATE.

This is to certify that the information contained in this schedule is complete and correct to the best of my knowledge and belief, and it covers the period from ....., 190 , to ....., 190 .

.....
(Signature and official designation of the person furnishing the information.)

.....
(Signature of special agent.)

.....
(Address of person furnishing the information.)

1. Character of ownership: State the form of ownership as it existed on the last day of the year covered by the report, whether individual, firm or partnership, incorporated company, municipal, or other form.....

2. If a consolidated company, give names and location of constituent companies included in this report, or write same on last page.....

3. If a reorganized company, give name of original company.....

4. If a subsidiary or leased company, give name and address of operating company or lessee.....

5. If the corporation or firm is engaged in any business or industry other than that of central-station work for electric light and power, state the character of such business or industry, and whether conducted in the same or separate plants..

6. Number of lamps: Account for all lamps wired for service on last day of year covered by report, irrespective of ownership. If actual number is not known give careful estimate.

Class.	Type of lamp.	Public. (Number.)	Commercial or other private. (Number.)	Total. (Number.)
Arc lamps:				
Direct current	Open			
	Inclosed			
Alternating current	Open			
	Inclosed			
Total	Open			
	Inclosed			
Incandescent lamps:				
Sixteen candlepower				
Thirty-two candlepower				
All other				
Total				
Other varieties (Nernst, vacuum, vapor, etc. [state kind])				
Lamps used by company to light its own properties, and not reported above: (For municipal plants include only lamps in power houses.)				
Arc				
Incandescent				
Other varieties (state kind)				

7. Miscellaneous statistics.	Number.
Stationary motors served (do not include small fan motors)	
Total capacity in horsepower	
Give estimate of number of small fan motors served	
Railway motor cars served	
Meters on consumption circuits (include all kinds, mechanical, chemical, etc.)	
Transformers in circuits for customers	
Total capacity in kilowatts	
Total number of customers furnished electric current	
Number of customers furnished electric current for heating or cooking apparatus	
Miles of street occupied by underground conduits for mains and feeders[1]	
(If underground conduits are rented from a municipality or commercial company, give particulars of agreement and annual rental paid, on last page of schedule.)	

Digitized by Google

8. Power-plant equipment.

Generating power plant.	500 H. P. or under.	Over 500 H. P. and under 1,000 H. P.	1,000 H. P. and under 2,000 H. P.	2,000 H. P. and under 5,000 H. P.	5,000 H. P. and over.
Steam engines, number					
Total capacity in horsepower					
Steam turbines, number					
Total capacity in horsepower					
Gas engines, number					
Total capacity in horsepower					
Water wheels, number					
Total capacity in horsepower					

Auxiliary engines for use within plant as accessories, etc.:

Number....., total capacity in horsepower.....

[1] Length to be stated in miles and decimals of a mile carried to two places.

9. Electrical generators: The kilowatt capacity, voltage, and amperage reported should represent a single machine. If more than one machine of the same class, give separate information for each.

	Number.	Total capacity in kilowatts of each machine.	Indicated voltage of each machine.	Indicated amperage of each machine.
Dynamos:				
Direct-current, constant-voltage				
Direct-current, constant-amperage				
Alternating and polyphase current				
Boosters				
Rotaries				
Storage-battery cells in main power plants				
Miscellaneous apparatus (state kind)				

10. Output of station: The output should be calculated from the voltage and amperage of the generators, or obtained from the actual watt or kilowatt readings of dynamo meters.

Kilowatt hours, average per day.....

Kilowatt hours, total for year.....

State the number of hours of operation, per day, if day circuits are not operated.....

11. Substation equipment: The kilowatt capacity, voltage, and amperage reported should represent a single machine. If more than one machine of the same class, give separate information for each.

Class.	Number.	Total capacity in kilowatts of each machine.	Indicated voltage of each machine.	Indicated amperage of each machine.
Storage battery, cells				
Transformers				
Rotary converters				
Miscellaneous apparatus (state kind)				

12. Cost of plant: The answer must show the total cost of land—buildings—machinery, tools, and implements within stations and shops—overhead and underground electric-service construction—lamps, motors, meters, and transformers wired for use—supplies of every description on hand not enumerated elsewhere. If land was donated, so state and give estimated value at time of donation, but *do not* include the amount in the total. For municipal plants *include* the preliminary cost of experts' reports, engineering plans, holding special elections, etc.

Cost during the year..... $.....

Cost to date..... $.....

Is value of franchise included? (Answer Yes or No).....

13. Supplies and materials used during the year for ordinary repairs and replacements: This inquiry is not intended to cover mercantile transactions, but if the company incidentally sells electric supplies and fixtures to its customers the quantity and cost of such supplies disposed of during the year should be included. If the company pays freight on any of the supplies and materials used, and the amount is not included in their cost, report the amount of this freight under "Amount of freight, if any, paid on the above." (Do not include expenditures for additions or extensions.)

Kind.	Number.	Cost.
Supplies:		
Meters		$.....
Motors		
Transformers		
Incandescent lamps		
Nernst lamps, vacuum and vapor lamps, etc		
Incandescent and other lamp fittings, sockets, etc. (Do not include arc-lamp supplies)		
Carbons, globes, hoods, and other supplies for arc lamps, including arc-lamp repairs		
Poles or other supports		
Wire and cable		
Fuel:		
Coal		
All other fuel (state kind)		
Electric current purchased for distribution[1]		
Power purchased (state kind)		
Rent of water privileges for water wheels or turbines		
All other supplies and materials, including water for boilers, mill supplies, etc.		
Total cost		$.....

Amount of freight, if any, paid on the above (not included in the "Cost"). $.....

[1] Give name and address of company from whom purchased.

14. Miscellaneous expenses.	Amount.
Rent of stations, and line-wire supports, conduits, or underground privileges	$.....
Rent of offices	
Taxes (state kind)	
Injuries and damages	
Insurance	
Ordinary repairs of buildings, machinery, etc. (Do not include amounts reported in Inquiry 13, "Supplies and materials")	
Amount paid for interest, advertising, office supplies, law expenses, telegraph and telephone service, and all other expense incident to operation and maintenance not elsewhere reported. (Do not include interest on bonds or dividends on stock)	
Total	$.....

15. Employees, salaries, and wages: The average number employed during the year is the number that would be required, at continuous employment, for the twelve months. If any of the persons enumerated were employed only a portion of the time, give only the wages paid in connection with the electric service. Account for all regular officers and employees whether engaged on maintenance, canvassing, collecting, operation, or otherwise. (Do not include employees engaged exclusively on additions or extensions.)

Digitized by Google

	Average number employed during the year.	Total amount paid in salaries and wages during the year.
Salaried employees:		
Salaried officers of corporation		$
Other officers (general managers, superintendents, electricians, and experts)		
Clerks and bookkeepers		
Total		$
Wage-earners (do not include salaried employees reported above):		
Foremen		
Inspectors		
Engineers		
All other employees (including firemen, dynamo and switchboard men, linemen, mechanics, and lamp trimmers)		
Total		$

16. Income: Give the total amount of income for the year as indicated by the books of the company. If accounts do not show the income from each class of service enumerated, give a carefully estimated segregation.

Commercial companies should include not only income from current actually sold, but also the estimated value of current supplied municipality or other government free of charge, the estimate to be based on the prevailing commercial rates. (Estimated value of current consumed by lamps and motors on the company's own properties should *not* be included.)

Municipal plants must include in answer to the inquiry the estimated value of current consumed in public buildings and in lighting streets, parks, etc., the estimate to be based on the prevailing commercial rates. (Estimated value of current consumed by lamps and motors in municipal-power houses should *not* be included.

Source.	Amount.
Lighting:	
Commercial or other private—	
Arc lamps	$
Incandescent lamps	
Other lamps	
Public, furnished municipality or other government for buildings and streets—	
Arc lamps	
Incandescent lamps	
Other lamps	
Motor service, stationary (not including small fan motors)	
Electric-railway service	
Sale of current to other electric companies	
Electric heating, cooking, welding, etc	
Charging automobiles	
All other electric service (specify items)	
Gross income from sale of supplies and fixtures	
Income from all other sources (specify items)	
Total	$

If a commercial company, give amount of estimated income for free service, which is included above $

If a municipal plant, give amount of estimated income represented by current consumed in public buildings and in lighting streets, parks, etc., which is included above $

17. Capital stock, bonds, dividends, and interest: If the company operates a gas or water plant or other industry in connection with the electric light and power plant, and it is impossible to segregate the capitalization, report the entire capital and give an estimate of the proportion chargeable to the electric light and power plant department.

	Number of shares or bonds.	Total par value.	Dividends declared and interest paid or due for the year.	
			Rate.	Amount.
Authorized capitalization by charter:				
Common stock		$	x x x x	x x x x x x
Preferred stock			x x x x	x x x x x x
Bonds			x x x x	x x x x x x
Capital stock and bonds outstanding:				
Common stock				$
Preferred stock				
Bonds				

Estimated proportion of above outstanding capitalization chargeable to the electric light and power plant department

18. Poles purchased during 1907.

Length, feet.	Cedar.		Chestnut.		Juniper.		Other species. (Specify.)	
	Number.	Average cost per pole at point of purchase.	Number.	Average cost per pole at point of purchase.	Number.	Average cost per pole at point of purchase.	Number.	Average cost per pole at point of purchase.
Under 20								
20 and over but under 25								
25 and over but under 30								
30 and over but under 35								
35 and over but under 40								
40 and over but under 45								
45 and over but under 50								
50 and over but under 55								
55 and over but under 60								
60 and over								

How many treated poles were purchased during 1907?

What preservative was used?

How many poles were treated during 1907?

What preservative was used?

Digitized by Google

Digitized by Google

APPENDIX B.

INSTRUCTIONS TO SPECIAL AGENTS.

Period covered.—The act of Congress, approved June 7, 1906, provides that every five years this office shall collect statistics relating to electric light and power stations. The census of this industry will relate to the year ending December 31, 1907, and all plants that were in existence during any portion of the year must be reported.

Special agents, daily reports, and correspondence.—The canvass will be made by the regular employees of the Census Office working under the supervision of the chief statistician for manufactures. The employees detailed for field work must make daily reports on Form 8–185b for every day on which they are actually employed. The daily reports, together with all schedules taken daily, must be forwarded by registered mail at the close of each day, in the return penalty envelope addressed to the Director of the Census. *The office number and the running number of the report should be placed on the daily report for all schedules sent in.* Inquiries concerning schedules or further instructions must be made by letter and not on the daily reports. Each inquiry or requisition should be made in a separate letter. Employees must give sufficient notice of the date they will complete the district to which they are assigned, so that, if necessary, they may be assigned to other territory without loss of time.

In all correspondence, make reference to office letters by date, and to schedules and memoranda containing criticism, by referring to the office number on the list and the full name and address of the company in question.

Day's work.—The relative efficiency of each employee engaged in field work will be determined by the number and completeness of the reports secured. Each daily report must account for the work of the day. Schedules *must not* be retained for a number of days and daily reports made out so as to show a fair average for each day.

Districts and lists.—The entire country has been divided into districts and one or more special agents will be assigned to each district. The agents will be held accountable for a thorough canvass of their respective districts. To assist in locating the plants to be enumerated, each agent will be furnished with a list giving the names, locations, and addresses of all electric properties covered by the census in the territory assigned him. These lists are based on information obtained from directories, postmasters, and other sources. *The agents must not accept them as complete, but must be constantly on the alert to discover other plants or systems*, especially municipal electric fire-alarm and police-patrol systems in towns of less than 2,500 inhabitants.

The different cities must be visited in the order named on the list, unless the agent finds that railroad connections and local conditions make a change advisable. In such cases the character and necessity for the change must be given on the agent's daily report.

An agent should not return to a city already canvassed to secure information for a report returned to him for correction unless especially advised to do so. It is believed that the agent will be able in most cases to supply the information from his knowledge of the conditions. If he can not do so, he should return the schedule to the office with such explanation for his error or neglect as he may be able to make. To obviate the necessity of returning schedules for additional information, the agent must be careful to secure *complete* reports for all plants before leaving a city.

Reports secured by mail.—Schedules were mailed to all companies, and if a *complete* report has been thus secured, the name on the agent's list will be marked "schedule received." If the mail report is unsatisfactory, the name will be stamped "incomplete schedule received," and the original schedule furnished the agent to complete. These schedules must be completed or corrected, signed, and returned by the agent. If it is found advisable to prepare a new report in place of the original, such report must be marked "corrected report" on the title page. Otherwise the agent will still be charged with the original schedule. If the agent has not been advised that the office is in receipt of the report, he must secure the same, although the company may claim that the schedule has been furnished.

Proposed plants.—Some of the names on the list are for plants or systems that were contemplated or projected, or supposed to be under construction, but not necessarily building or in operation; when possible, such plants have been designated as "proposed," or as "under construction." These plants should not be visited when it requires a special trip unless the agent can obtain information that they were actually in operation. If for other purposes the agent visits a place where such a plant or system is supposed to be located, he must account for the name on his daily report and give information which will enable the office to dispose of the name on the office list.

Idle plants.—The instructions in the preceding paragraph in regard to "proposed" plants are applicable also to idle plants. While the census is to cover all plants that were in existence during 1907, the agent should not make a special trip to secure the report of a plant that was not in operation during any part of the year.

New plants.—If a report is secured for a listed company under a name other than that given on the agent's list, a memorandum must be made on the schedule giving the name of the company as it appears on the list. If this is not done, the name will remain on the list as charged to the agent. If schedules are secured for plants not on the list, the words "not on list" must be written in the upper left-hand corner of the title page.

Central offices.—A large number of properties are controlled from offices located elsewhere than at the plants. When known, central offices of this character are indicated on the lists with the names of the plants for which reports will be prepared at the central office. Agents canvassing the districts in which central offices are located must in every instance secure reports from these offices before canvassing the other plants. A large number of controlling companies have advised the office that reports for certain properties will be prepared at their office. The names of these controlled companies will appear on the agent's list without a number, but with a notation "see central office," or "report will be secured at ———." Agents must not secure reports for these controlled companies unless especially directed to do so. If in the city, the agent should call at such plants and explain that a census of electrical industries is being taken; also that it is understood the report is being prepared at the central office of the company. He should also leave blank schedules, explaining the requirements of the census, so that the local officials will know just what information is required if the central office requests them to furnish data for the reports.

If a plant is owned by a company whose business office is in

Digitized by Google

another locality outside the territory assigned the agent and a portion of the information must be obtained from such office, the agent should complete the schedule so far as possible from the data obtainable at the plant and forward it to the Census Office with a full statement of the facts, giving also the names and addresses of the persons from whom further information can be obtained. The agent must, however, exhaust every reasonable means to complete the report before sending it in to the Census Office.

Annual reports.—In all cases where an annual report of the company is printed, a copy of the latest report should be secured and forwarded with the schedule. Copies should also be returned of the latest report of the directors or officers of the company, or other printed matter that would add to the information contained in the schedule.

The schedule.—An exact answer to each question enumerated in the several inquiries is what is required, and is what should be given if it can be secured with a reasonable amount of labor. It is anticipated, however, that in a number of cases the accounts are not kept under just such a series of items as is enumerated in the schedule. If the accounts cover two or more of the items enumerated for any of the inquiries, the total should be equitably apportioned for the reply to each subinquiry. In all cases where the answers are estimated the amounts must be preceded by the word "estimate."

All answers must be made clearly and neatly in ink. Amounts and values must be obtained from book accounts, if such accounts are available. Each question is to be answered. If any question is found not applicable and no amounts are reported, write the word "none."

The following instructions, in addition to those on the schedule, should be followed by the agents in preparing all reports:

The title-page.—Page 1 must contain the name and location of the company, the address of the general office, and the signature, address, and official designation of the person furnishing the information. *Place the office number and the running number of the report in the upper right-hand corner.* If the address of the general or business office is at a different place from that of the plant, care must be taken to give both.

The reports for plants that were in operation only a portion of the census year will be tabulated separately; therefore it is essential to give on the title-page the exact period covered by each report.

Reports must be secured for all electric plants doing a public-service business; that is, for all plants, whether owned or operated by individuals, companies, corporations, or municipalities, established for the purpose of generating electric current for sale, that were in existence during any portion of the year ending December 31, 1907.

No report is required for isolated electric light or power plants operated primarily for the benefit of the owner in lighting and furnishing power for his factory, hotel, or other enterprise, even though some current may be sold. The instructions on the title-page of the schedule provide that "isolated plants which incidentally sell current must be reported." This was intended for the guidance of persons who would receive the blank schedule through the mail, and to avoid the possibility of omitting any central stations. Such plants can not be considered as central stations, and agents must not secure reports for them.

Electric plants owned by the United States Government and operated primarily for supplying light or power to public buildings, military posts, naval stations, Indian reservations, etc., should be considered isolated plants and no report secured; also electric plants owned by and operated primarily for the benefit of state institutions.

Combined reports.—If the electric plant is operated in connection with an electric railway, separate reports should, if possible, be prepared. If this can not be done, a combined report should be prepared on the railway schedule.

If the electric plant is operated in connection with any business other than a street railway and the system of accounts will not permit of the preparation of a separate return, careful estimates must be prepared for answer to all the questions contained in the schedule; these estimates must be prepared by, or submitted to and approved by, the person furnishing the information. The items of cost of plant; supplies and materials; miscellaneous expenses; employees, salaries, and wages, and income, must pertain only to the electric light or power station.

Where two or more plants are owned by one individual, company, or corporation, and located in the same city or town, one combined report may be secured. In such cases the number of separate plants included in the report should be stated in answer to inquiry 2. Light and power plants operated by the same corporation, firm, or individual, and located in different states, counties, cities, or towns should be reported separately.

Inquiries 1 to 5, inclusive.

These are intended to obtain information concerning the character of the organization under which the company is operated, the character of the changes in such organization, and whether or not conducted in connection with some other industry. The answers given to each of these questions must be consistent.

Inquiry 6.—Number of lamps.

The answers to this inquiry must show the total number of the different varieties of lamps connected or wired ready to render service, and not the number actually performing service at any one time. The total must include all lamps in position to earn an income, irrespective of their ownership. Therefore it may include many lamps that are *not owned* by the company. If there is no record of the actual number of lamps, secure a careful estimate. The distinction between "public" and "commercial or private" lighting must be carefully preserved. This public service is the lighting of streets, parks, public buildings, and all other public places for the illumination of which the municipality or other form of government is responsible.

Open arc electric lamps are usually employed in street lighting, and are those having either one or two pairs of carbons inclosed in a single large globe. They are designed to burn a small number of hours (ten to fifteen) before having the carbon renewed. An inclosed arc lamp has two globes, a large or outer one inclosing a small one in which a single pair of carbons is incased, and is designed to burn a large number of hours (one hundred to one hundred and fifty) before having the carbons renewed. Both kinds may be either of the direct-current or of the alternating-current type.

Inquiry 7.—Miscellaneous statistics.

Stationary motors.—This term is applied by central station men to electric motors that are permanently located in one place, as distinguished from electric railway motors on cars. Such stationary motors will cover an infinite variety of work, and in many cases the companies will have difficulty in reporting the number of motors on their circuits, or in giving the separate income from motors (inquiry 16), especially where current is furnished through meters. But the inquiry must be pushed, and where exact figures can not be given from records it is desirable that a close estimate be secured. The field covered by these stationary motors will include every class of industrial work and many other methods of application, such as in running large ventilating fans, elevators, etc. It is a custom of many companies to make special rates for what they call "power" business, as distinct from that done in supplying current for lamps; and where this is the case, their records should show the data as to motor service and income.

The actual or the estimated number of small fan motors and railway motor cars served with current should be reported for every plant.

Meters on consumption circuits.—This inquiry applies solely to meters installed on the consumers' premises, just as gas meters are, and does not relate to meters installed at the central station.

Transformers in circuits for customers.—The number and total capacity in kilowatts of all transformers in circuits for customers should be reported here.

Digitized by Google

A great deal of electrical work in scattered communities is done with the aid of transformers, which are also to be found in some of the larger cities at the customers' end of the line, although as a general thing in large city plants it is the practice to furnish direct current to the consumer, in which case transformers are not needed outside the station or substation. Where the lamps in a customer's house or store are fed with alternating current, the transformers are placed on an adjacent pole or in a cellar or other room where they are not generally accessible, as the primary voltage is dangerous to life. The current is sent out at a high pressure from the central station and is received by the primary coil in the transformer at perhaps 1,000 to 2,000 volts. The secondary coil takes the small-quantity high-pressure current from the primary coil and transforms it into large-quantity low-pressure current for use in the lamps, motors, etc. The coils and the iron core they surround are inclosed in water-tight metal boxes, which present a rough resemblance to mail boxes and fire-alarm boxes.

Inquiries 8 and 9.—Power-plant equipment and electrical generators.

The capacity of the engines and water wheels and of the dynamos is closely related. The engines and water wheels, as a rule, have an excess capacity over that of the dynamos. "Auxiliary engines" will sometimes be found in small stations, but in the larger plants electric motors are in common use to drive pumps, etc., and the superintendent or manager can readily enumerate them.

There will be no difficulty in ascertaining the facts as to the different classes of dynamos. The voltage of machines for lighting purposes varies greatly. In all cases the kilowatt capacity, voltage, and amperage reported must represent a single machine. If there is more than one machine of the same class, give separate information for each.

Storage batteries are used, either in the main power plants or in the substations, to help maintain a steady supply of current at the right pressure, and "boosters" are dynamos assisting to the same end. The substation is particularly a feature of long-distance work, but competent engineers are generally to be found who can give the substation equipment should it not be in possession of the management.

Inquiry 10.—Output of Station.

The kilowatt hours may be tested by the earnings. The average earnings per kilowatt hour for all plants at the census of 1902 was about 3½ cents. The average varies considerably for individual plants, but if the average is less than 1 cent or more than 15 cents per kilowatt hour, the figures should be questioned and if found correct, explanation made.

A standard arc lamp consumes from 450 to 550 watts per hour; ordinary standard incandescent lamps of 16 candlepower have an average consumption per hour of about 3.1 watts per candlepower. Many incandescent lamps now in use, like the tantalum, take less.

In all calculations of average earnings per kilowatt hour and consumption of current per lamp, etc., the loss of current in transmission must be considered.

Inquiry 11.—Substation equipment.

The feature of substation equipment is that it does not generate current, but receives it, manipulates it, stores it, and lowers the pressure or changes the form for local consumption. All the generating plants will usually be found in the generating stations, but sometimes substation apparatus will be found under the same roof as the main generating plant apparatus.

Inquiry 12.—Cost of plant.

The answer to this inquiry must show the total cost of the plant and equipment up to the end of the year for which the report is made, with a separate statement of the cost of additions and extensions during the year. The cost of plant must include all expenses incident to the organization of the company and the establishment of the plant. If the land was donated, that fact should be stated and the estimated value at the time of the donation given separately, but not included in the total.

Inquiry 13.—Supplies and materials used during the year for ordinary repairs and replacements.

The actual cost of all materials and supplies used during the year must be reported. In answering this inquiry report only the materials and supplies that were used for ordinary repairs or replacement during the year reported. Expenditures for additions to the plant, such as new machinery, or additional lines on which new meters, motors or transformers, or lamps are installed, should be included in answer to inquiry 12, cost of plant.

As a rule all equipment that adds to the capacity of the plant should be regarded as "extension" and whatever merely sustains existing efficiency as "repairs." Incandescent lamps are often paid for by the central-station customers. If this is the case, only those used in renewing street lamps or such others as the company is responsible for should be reported. The quantity (number) and cost should be given for the first five articles listed under supplies. If large quantities of supplies or fuel were purchased with a view of taking advantage of low prices, that fact must be stated in a footnote, but in such cases the answer to the inquiry should show only the quantity and cost of such as were consumed during the year.

The cost of water hired or rented to run water wheels or turbines should be reported in answer to the question "rent of water privileges for water wheels or turbines." The amount paid annually for land used for obtaining a water supply should not be reported in answer to this question, but should be included under the first question of inquiry 14—miscellaneous expenses.

Amount of freight, if any, paid on the above (not included in the "cost").—If the company reporting pays freight on any of the supplies and materials used, and the amount is *not* included in their cost, the amount of the freight should be reported in answer to this question.

Inquiry 14.—Miscellaneous expenses.

All items of expense incident to the business for the year and not included in answer to inquiries 13 and 15 must be reported here. Do not include any portion of the freight reported under inquiry 13 as paid on supplies and materials. Expenses incident to additions or extensions of the plant or line should not be included in answer to inquiries 13, 14, or 15. The cost of such additions must be reported as cost of plant—inquiry 12.

Inquiry 15.—Employees, salaries, and wages.

Account for all regular employees of the company who were required to supervise and keep up the usual work of the plant. Do not include those employed exclusively on extension work. Give the number of officers who receive salaries (not the number of stockholders) and the gross amount of their salaries. Report separately the number and wages of foremen, inspectors, and engineers. In a few cases the company may rent houses to, or possibly board, its employees at a reduced rate; in such cases the salaries and wages reported should include the allowance for board or rent furnished as part compensation. The average number employed during the year is the number that would be required, at continuous employment, for the twelve months. There should be no difficulty in securing this information for the plant of ordinary size, but it may be that the large companies keep an itemized pay roll, the total only being carried forward each week or month. In such cases it will be necessary either to add the pay roll of each week or month, for each class of employees, or to compute the aggregate for each class, using a pay roll for a representative week or month as the base. Results obtained by the latter method will be accepted.

Inquiry 16.—Income.

The total amount of income indicated by the books of the company for the entire year should be reported. Give separate amounts

Digitized by Google

for the different sources enumerated. Electric companies frequently furnish free service to the municipality in which they are located, such as the illumination of some or all of the public buildings, the supply of a certain number of lamps, or the granting of a special discount on the lamps used, or in other ways make a return for the ordinance or franchise by which the company was granted the use of the streets. The value of this free service must be estimated and included as indicated by the inquiry, and must also be stated separately in answer to the subquestion, "If a commercial company, give amount of estimated income for free service, which is included above."

It is essential to show separately the income from commercial or private service and public service. If incandescent and arc lamps are connected on the same meter, and it is found impossible to separate the income, the total income for both classes of service should be ascertained and a careful estimate made for the two classes. Public-lighting contracts are usually made for a term of years. The customary contract is based on what is known as a lighting schedule. Two principal schedules which show the extremes are, respectively, designated by business men as the "all-night-and-every-night schedule," estimated at 4,000 hours per year, and the "dark-of-moon, every-night, one-hour-after-sunset-until-12-o'clock-midnight schedule," estimated at 1,200 hours per year. Between these extremes are numberless variations. The income received from public service, therefore, can be very easily ascertained. If this income is not shown separately for arc lighting and incandescent lighting, the separation should be estimated in the same manner as above indicated for arc lighting and incandescent lighting in general.

Electrical signs have become quite an important feature of central station work. These signs are usually lighted by incandescent lamps, and the income from this service should be accounted for under the proper item of inquiry 16, and the number of lamps wired for service included under inquiry 6.

Under normal conditions the net income—i. e., the total income for the year as reported in inquiry 16, less the total expenses of operation and maintenance (the sum of the totals of inquiries 13, 14, and 15)—should be sufficient to pay the dividends on stock and the interest on bonds reported in inquiry 17. If the net income is not sufficient to pay the dividends and interest for the year, or if a net deficit is indicated for the year's operations, attention should be called to this fact, and if found correct, explanation made under "remarks."

Inquiry 17.—Capital stock, bonds, dividends, and interest.

Account for the entire amount of stock and bonds authorized by charter and the amount outstanding on the last day of the year covered by the report. Give full amount of dividends declared and interest paid or due for the year. The *rate* of interest should always be stated, even though no interest may have been paid or due for the year.

If some other industry is carried on in connection with and by the use of the same capitalization, the estimated proportion chargeable to the electric light and power plant department may be based upon the ratio between the income of the lighting plant and the total income from all departments represented by the entire capital liability.

Inquiry 18.—Poles purchased during 1907.

This inquiry is separate and distinct and bears no direct relation to the other inquiries of the schedule. The instructions on the schedule should be applied, and the questions answered for all companies or plants.

MUNICIPAL PLANTS.

Schedule B2-231 is prepared primarily for plants owned by individuals, companies, or corporations. In applying this schedule to plants owned and operated by municipalities certain changes will be necessary. These changes should be made by the agent, and additional information, when required, must be given under "remarks" on the last page of the schedule.

It will often occur that the administration of a municipal plant is assigned to a public officer or officers performing other duties, or that a part or all of the labor of collecting and accounting is done in the office of some other department—waterworks, for example. If, in these cases, a general account is kept for two or more departments, such as water, streets, etc., the expenses for the electric plant should be apportioned equitably. The following plan is suggested to aid in arriving at an equitable apportionment of the salaries, wages, miscellaneous expenses, etc.: For officers, clerks, and all employees, charge to each service the same proportion of the total amount paid in salaries or wages as the time devoted to that service constitutes of the whole time worked; for rent and all sundry office expenses, charge in proportion to the income of each service; for insurance, taxes, law expenses, interest, and all contingent expenses, in proportion to the amount of investment; for fuel, water, and all other power expenses, in proportion to the horsepower utilized by each service.

Inquiry 12—Cost of plant.—The installation of municipal plants is frequently attended by a preliminary cost for experts' reports, engineering plans, specifications, printing, advertising, holding a special election, traveling inspection by a special committee, etc., which would not, under ordinary circumstances, be included in the cost of the plant. Care must be taken in all cases of this character to include such expenses in answer to this inquiry.

Inquiry 16—Income.—As shown by the instructions on the schedule, the income for municipal plants must include not only the actual cash received for service to private interests, but also the value of the service to the city if paid for at prevailing commercial rates, because the industry must be charged with all expenditures incident to it for the year and therefore should be credited with an income for all service rendered and which was made possible by the expenditure. As called for by the last subquestion of the inquiry, an estimate of the income of the municipality's own free service is required separately.

Inquiry 17—Capital stock, bonds, dividends, and interest.—The portion of the inquiry relative to capital stock and dividends is not applicable to municipal plants. As a rule there is a special bond issue to cover the installation of the electric plant. The amount of such bonds authorized by the special act and the amount outstanding at the end of the year, together with the interest paid or due for the year, should be reported. If, however, there was no special issue of bonds, the cost of the electric plant being met by proceeds of a general bond issue or special tax fund, a full explanation of the arrangement and a description of the general bond issue or special tax should be given under "remarks."

Digitized by Google

INDEX.

Alabama, increase in total cost of construction, 71. *See also* States and territories.
American Institute of Electrical Engineers, description of illumination at twenty-fifth anniversary of, 112.
Apparatus, miscellaneous, kilowatt capacity of, for commercial and municipal stations (combined), 135, 136; for commercial stations, 151, 152; for municipal stations, 169.
Appleton, Joseph, extract from paper concerning batteries, 106.
Arc lamps, number of, for commercial stations, 53, 54; for municipal stations, 53, 54; for commercial and municipal stations (combined), 127; average per station, 60; supplies and repairs, cost of, for commercial stations, 93, 161; for municipal stations, 93, 175; for commercial and municipal stations (combined), 141; rapid development of new types, 106.
—— flaming, types of, 106.
—— luminous magnetite, description of, 107.
—— wired for service, number of, for central stations operated by street-railway companies, 17, 180; for commercial and municipal stations (combined), 138; for commercial stations, 154; for municipal stations, 170. *See also* Lamps, arc and incandescent.
Arc lighting, number of stations selling current, 59. *See also* Arc lamps.
Arch lighting, varieties of, 111.
Arizona, decrease in total cost of new construction, 73. *See also* States and territories.
Arkansas, increase in total cost of new construction, 73. *See also* States and territories.
Aurora, Ill., installation of arch lighting, 111.
Automobiles, supply of current for, by central station, 115; income from charging, for commercial and municipal stations (combined), 142; for commercial stations, 159; for municipal stations, 176.

Ballard, R. H., on transmission of current, 102.
Baltimore, Md., number and horsepower of steam turbines, 42.
Bath, Ill., primary power and dynamo capacity, for municipal station, 26.
Bell, Dr. Louis, on power transmission, 102; decision as to candlepower of mercury vapor lamps, 113.
Big Horn, Wyo., utilization of water pressure for dams, 99.
Big Rapids, Mich., description of arch lighting, 111.
Board of Gas and Electric Light Commissioners (Mass.), meters examined and tested by, 118; decision regarding rates, 123.
Bonds, authorized and outstanding, par value, for commercial stations, 157; for municipal stations, 172.
Bookkeepers. *See* Clerks and bookkeepers.
Boosters, number and kilowatt capacity of, for commercial and municipal stations (combined), 135; for commercial stations, 151; for municipal stations, 169.
Boston, Mass., number and horsepower of steam turbines, 42.
Boston Edison Company, increase in area of system, 96.
"Breakdown" service. *See* Service, "breakdown."
Brooklyn Edison Company, amount received per month for service, 114.
Buffalo, N. Y., number of fans for refrigerating purposes, 115.
Buildings and machinery, repairs of. *See* Repairs of buildings and machinery.

Cable. *See* Wire and cable.
California, number of plants for generation of electricity, 22; horsepower of steam power, 39; number and horsepower of steam engines, 41; of stationary motors, 59; horsepower of gas engines, 42; increase in water power, 43; kilowatt capacity of dynamos, 49; lamps, arc and incandescent, 56; meters on consumption circuits, 57; number and kilowatt capacity of transformers in circuits, 58; increase in total cost of construction, 71; rank, in expenditure for new construction, 73; cost of construction, for commercial stations, 74; gross income, 82; from commercial and public lighting, 86; from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 88; method of holding up wires, 102; length of circuits, 102. *See also* States and territories.
California Gas and Electric Corporation, horsepower and dimension of engines, 98.
Callahan, E. I., on advantages of electric-heating load, 116.
Canada, rates for testing meters, 118.
Canadian Niagara Power Company, capacity of turbines, 100.
Canvass, basis of, 15.
Capital, difficulty attending segregation of, 13.
Capital stock, amount of, for companies reporting capitalization, 65, 67, 68; authorized and outstanding, par value, for commercial stations, 156. *See also* Capitalization.
Capitalization, increase in, 61; number of companies reporting, 61, 63–65; amount of, for purely electric and composite companies, 62, 63; for commercial companies, 67; for incorporated companies, 74, 75; distribution between electric light and power industry and allied industries, 63; per cent distribution and average per company, 68.
Cells, storage battery. *See* Storage-battery cells.
Cells in storage batteries, number of, for commercial and municipal stations (combined), 136; for commercial stations, 152.
Central stations, number of, 16; relation of leading items to population, 22, 24; generating equipment, for selected cities, 24, 25; dynamo capacity, 27; comparison with gas plants, 28; with electric railways, 36, 52; primary-power machines, 35; primary power, by states, diagram, 37; steam and water power, by states, diagram, 40; steam turbines, for selected cities, 42; dynamos, 44–48; output of generating stations, 50, 51; lamp equipment, 56; meters on consumption circuits, for selected states, 57; transformers in circuits, 58; stationary motors, 59; gross income, maps, 77; for selected states, 82, 86; changes in use of steam power, 97.
Central stations and gas plants, comparative summary, 28.
Central stations operated by street-railway companies, summary of statistics, 17.
Chicago, Ill., number and horsepower of steam turbines, 25, 42; primary power and dynamo capacity, for municipal station, 26.
Chicago City Railway, cost of contract for electrical energy, 114.
Cincinnati, Ohio, number and horsepower of steam turbines, 42.
Clerks and bookkeepers, number and salaries of, for commercial and municipal stations (combined), 143; for commercial stations, 162; for municipal stations, 177.
Cleveland, Ohio, number and horsepower of steam turbines, 42.
Coal. *See* Fuel.
Colorado, kilowatt capacity of dynamos, 49; increase in total cost of construction, 71; cost of construction, for commercial stations, 74; gross income, from commercial and public lighting, 86; from stationary-motor service, 87. *See also* States and territories.
Commercial and municipal stations (combined), number of, 72; cost of plants and equipment, 72; of construction, 73; gross income, 79; by kind of power used, 83; for stations with and without meters on consumption circuits, 84; from stationary-motor service, for selected states, 87; from current sold to electric railways and to other electric companies, 88; expenses, 91, 145; summary, 126; primary power and generating equipment, 130.
Commercial companies, capitalization of, 61; classified according to dynamo capacity of stations, 67.
Commercial stations, comparison with municipal stations, 13; number of, 16; by character of ownership, 17; by dynamo capacity, 26; kind of associated enterprises, 27; changed to municipal, 29; primary-power machines, 36, 38; number and horsepower of steam engines and steam turbines (combined), 38; of steam engines, 39; of steam turbines, 41; of water wheels, 43; average horsepower per station and per machine, 43; kinds of primary power, 44; dynamos, 46, 47; miscellaneous main-station equipment, 49; substation equipment, 49; output of generating stations, 50; lamps, meters, transformers in circuits, and stationary motors, 53, 60; arc lamps, 53, 54; incandescent lamps, 53, 55; dynamo capacity, 67; total cost of plants and equipment, 70, 72; of construction, 70, 74; gross income, 76, 80, 158, 159; for stations with and without meters on consumption circuits, 84; from commercial and public lighting, 85; from current sold to electric railways, 87, 88; from miscellaneous electric service, 88; expenses, 89, 95, 164; employees, salaries, and wages, 92, 162, 163; cost of supplies, materials, and fuel, 93, 94, 160, 161; primary power and generating equipment, 146; substation equipment, motors, transformers, meters, customers, and output of stations, 152; analysis of service, 154; character of ownership, service, capitalization, and cost of construction and equipment, 156.

Digitized by Google

Common stock, classification of, 65. *See also* Capital stock.
Commonwealth Edison Company (Chicago), development of stations by, 97; capacity of vertical-shaft machine, 101; sale of electrical energy for power purposes, 114; rates charged, 121.
Companies, number of, reporting capitalization, 64, 65; funded debt, 66, 67; paying and not paying dividends on preferred stock, 66; dynamo capacity, 68.
—— incorporated, average rate of return on capitalization of, 62.
—— without generating equipment, number of, 67, 68.
"Composite," use of term, 13.
Composite central stations, number of, 27; gross income, 78; expenses, 90.
Composite commercial stations, number and gross income of, 81.
Composite companies, number and capitalization of, 63.
Composite municipal stations, funded debt and interest of, 69; number and gross income, 81.
Conduits, rent of. *See* Rent of stations, line-wire supports, and conduits.
Connecticut, number and horsepower of internal-combustion oil engines, 42; kilowatt capacity of dynamos, 49; gross income from stationary-motor service, 87. *See also* States and territories.
Conservation conference, subject of study, 97.
Construction, cost of, 70, 73, 74; increase in, 71. *See also* Construction and equipment.
Construction and equipment, cost of, for commercial stations, 16, 18, 157; for municipal stations, 16, 30, 172; for purely electric and composite stations, 19, 20; for central electric stations and gas plants, 28; for stations under construction, 74, 75; for commercial and municipal stations (combined), 126.
Cooking, electric, data concerning, 115, 116.
Cooley, Professor, on perpetual and limited franchise, 121.
Current sold to other electric companies, income from, for commercial and municipal stations (combined), 142; for commercial stations, 159; for municipal stations, 176; for central stations operated by street-railway companies, 182.
Custer Reservoir (Colo.), height of dam, 99.
Customers furnished electric current, number of, for commercial and municipal stations (combined), 137; for commercial stations, 153; for municipal stations, 165.

Damages. *See* Injuries and damages.
Delaware, decrease in total cost of new construction, 73. *See also* States and territories.
Delta, Pa., utilization of water power for dam, 99.
Denver, Colo., number and horsepower of steam turbines, 42; number of fans for refrigerating purposes, 115; rate system, 123.
Denver Gas and Electric Company, change from direct to alternating current, 104.
Detroit, Mich., establishment of new plant, 104.
Distribution, methods of, 103.
Dividends and interest, amount of, 63, 156, 157; analysis of, 64, per cent distribution, 68. *See also* Capitalization.
Doherty system, basis of, 123.
Duffy, C. M., uniform accounting approved by, 122.
Dunham, ——, data regarding meter measurement, 119.
Dynamo capacity, of commercial and municipal stations, 26; of purely electric and composite stations, 27; of central stations, 27.
Dynamos, number and kilowatt capacity of, for commercial stations, 16, 18, 44, 46, 148; for municipal stations, 16, 44, 46, 167; for purely electric and composite stations, 19; for central stations, 44, 47, 48; for electric railways, 44; relation to population, 22, 31; average kilowatt capacity per station and per machine, 46; for selected states, 49; cost per kilowatt capacity, 70.

Edison Electric Illuminating Company (Boston), system of rates, 123.
Electric light and power industry, bonds outstanding and interest, 69.
Electric power, development in, 113.
Electrical Development Company (Niagara Falls, Ont.), capacity of turbines, 100.
Electrical energy, development and use of, 22.
Ellicott City, Md., utilization of water power for dam, 99.
Employees, miscellaneous, number and wages of, for commercial and municipal stations (combined), 144; for commercial stations, 163; for municipal stations, 178.
—— salaried. *See* Salaried employees.
Engineers, number and wages of, for commercial and municipal stations (combined), 144; for commercial stations, 163; for municipal stations, 178.
Engines, auxiliary, number and horsepower of, for commercial stations, 18, 36, 148; for purely electric and composite stations, 19; for central stations and electric railways, 35; for municipal stations, 36, 167; for commercial and municipal stations (combined), 132; average horsepower per station and per machine, 43.
—— gas, number of, for commercial stations, 16, 18, 36, 148; for municipal stations, 16, 36, 167; for purely electric and composite stations, 19; for central stations and electric railways, 35; for commercial and municipal stations (combined), 132; classes of, 42; average horsepower per station and per machine, 43; description of, 98.
—— internal-combustion oil, number and horsepower of, 42; description of, 98.
—— reciprocating, installation of, 97.
—— steam, number of, for commercial stations, 18, 36, 146; for purely electric and composite stations, 19; for central stations and electric railways, 35; for municipal stations, 36, 166; for commercial and municipal stations (combined), 130.
Engines and water wheels, horsepower of, 22, 127; average cost per horsepower capacity, 70.
Equipment, number and kilowatt capacity of substation, 49; generating and other main-station, 132, 148, 167.
—— miscellaneous main-station, number and kilowatt capacity of, 49. *See also* Construction and equipment.
Establishments, number of, for central electric stations and gas plants, 28.
Expenses, for commercial stations, 16, 18, 89, 158, 164; for municipal stations, 16, 31, 89, 173, 179; for purely electric and composite stations, 19, 20, 90; for commercial and municipal stations (combined), 91, 126, 145.
—— miscellaneous, for commercial stations, 89, 95, 164; for municipal stations, 89, 95, 179; for purely electric and composite stations, 90; for commercial and municipal stations (combined), 91, 145.

Fans, for refrigerating purposes, number of, in specified cities, 115.
Flatirons, electric, introduction and use of, 116.
Florida, increase in total cost of new construction, 73. *See also* States and territories.
Foremen, average number and wages of, for commercial and municipal stations (combined), 144; for commercial stations, 163; for municipal stations, 178.
Freight, cost of, for commercial stations, 93, 161; for municipal stations, 93, 175; for commercial and municipal stations (combined), 141.
Fuel, cost of, for commercial stations, 89, 94, 161; for municipal stations, 89, 94, 175; for purely electric and composite stations, 90; for commercial and municipal stations (combined), 91, 127, 141. *See also* Supplies, materials, and fuel.
Funded debt, companies reporting, 66, 67; per cent distribution, according to dynamo capacity, 68; amount of, for municipal stations, 69; for purely electric and composite stations, 69. *See also* Capitalization.

Ganz, Prof. Albert F., on popularity of metallic-filament lamps, 108.
Gas, manufactured and natural. *See* Fuel.
Gas engines. *See* Engines, gas.
Gas plants. *See* Central stations and gas plants.
"Gem" lamps, number of, 57; power consumption, 108; carbon lamps replaced by, 109.
Generating equipment, number and kilowatt capacity of dynamos, for commercial stations, 16, 18, 148; for municipal stations, 16, 167; for purely electric and composite stations, 19, 20; for commercial and municipal stations (combined), 132. *See also* Equipment.
Generators, data concerning, 100.
Georgia, increase in water power, 43; in total cost of construction, 71; kilowatt capacity of dynamos, 49. *See also* States and territories.
"Glower" lamps. *See* Nernst or "glower" lamps.
Gossler system, adoption of, 113.
Grand Rapids, Mich., description of arch lighting, 111.
Great Northern Company (Duluth, Minn.), capacity of transformers, 105.
Great Western Power Company (Cal.), capacity of transformers, 105.

Hartford, Conn., number and horsepower of steam turbines, 42.
Hartford Electric Light Company, variation in meter practice, by introduction of tungsten lamps, 119.
Hawaii. *See* States and territories.
Heating, electric, income from, for commercial and municipal stations (combined), 142; for commercial stations, 159; for municipal stations, 176.
Heating and cooking, electric, cost of, compared with other methods, 115. *See* also Cooking, electric.
Hewitt, Dr. Peter Cooper, introduction of mercury vapor lamps by, 113.

Idaho. *See* States and territories.
Illinois, horsepower of steam power, 39; number and horsepower of steam engines, 41; of internal-combustion oil engines, 42; of stationary motors, 59; kilowatt capacity of dynamos, 49; lamps, arc and incandescent, 56; meters on consumption circuits, 57; number and kilowatt capacity of transformers in circuits, 58; increase in total cost of construction, 71; rank, in expenditure for new construction, 73; cost of construction, for commercial stations, 74; gross income, 82; from commercial and public lighting, 86; from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 88. *See also* States and territories.

Digitized by Google

Incandescent lamps, number of, for commercial stations, 55, 160; for municipal stations, 55, 174; for commercial and municipal stations (combined), 127, 140; average per station, 60; cost of, for commercial stations, 93, 160; for municipal stations, 93, 174; for commercial and municipal stations (combined), 140; change from carbon-filament to metallic-filament, 108.
—— having filament of tungsten, consumption of, 109.
—— wired for service, number of, for central stations operated by street-railway companies, 17, 181; for commercial and municipal stations (combined), 139; for commercial stations, 155; for municipal stations, 171. *See also* Lamps, arc and incandescent.
Incandescent lighting, number of stations selling current, 59.
Income, amount of, for central stations operated by street-railway companies, 17, 182; for commercial stations, 16, 18, 76, 80, 84, 158; for municipal stations, 16, 30, 76, 80, 84, 173, 176; for purely electric and composite stations, 19, 20, 78, 80, 81; for central stations, 77, 82; for central stations and gas plants, 28; for commercial and municipal stations (combined), 79, 83, 126; from commercial and public lighting, 85, 86; from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 87, 88.
Incorporated companies. *See* Companies, incorporated.
Indiana, kilowatt capacity of dynamos, 49; meters on consumption circuits, 57; number and kilowatt capacity of transformers in circuits, 58; increase in total cost of construction, 71; gross income, 82; from commercial and public lighting, 86; from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 88. *See also* States and territories.
Indiana and Michigan Electric Company, character of water-power plant, 99.
Indianapolis, Ind., number and horsepower of steam turbines, 42.
Injuries and damages, cost of, for commercial stations, 95, 164; for municipal stations, 95, 179; for commercial and municipal stations (combined), 145.
Inspectors, average number and wages of, for commercial and municipal stations (combined), 144; for commercial stations, 163; for municipal stations, 178.
Insurance, cost of, for commercial stations, 95, 164; for municipal stations, 95, 179; for commercial and municipal stations (combined), 145. *See also* Rents, taxes, and insurance.
Interest. *See* Dividends and interest.
Iowa, decrease in total cost of new construction, 73; gross income, from commercial and public lighting, 86; from stationary-motor service, 87.

Kansas, kilowatt capacity of dynamos, 49; gross income from stationary-motor service, 87. *See also* States and territories.
Keene Gas and Electric Company (N. H.), complex use of power, 98.
Kentucky, decrease in total cost of new construction, 73; gross income from stationary-motor service, 87. *See also* States and territories.

La Crosse Gas and Electric Company, application for higher rates, 120.
Lamp fittings (except for arc lamps), cost of, for commercial stations, 93, 160; for municipal stations, 93, 175; for commercial and municipal stations (combined), 140.
Lamps, arc and incandescent, total number of, 22, 53; for central stations and electric railways, 52; for selected states, 56; average income from, 86.
—— other than arc and incandescent, number of, for central stations and electric railways, 52; for commercial stations, 53, 55, 160; for municipal stations, 53, 55, 171; for central stations, 57; for commercial and municipal stations (combined), 140; for central stations operated by street-railway companies, 181.
—— quartz mercury vapor, specific consumption of, 113.
—— used by central stations to light their own properties, 52, 53.
—— wired for service, number of, for commercial stations, 16, 18, 154; for municipal stations, 16, 31, 170; for central stations operated by street-railway companies, 17, 180; for purely electric and composite stations, 19, 20; for commercial and municipal stations (combined), 138, 139. *See also* Arc lamps *and* Incandescent lamps.
Layman, W. K., quoted concerning transformers, 105.
Line construction, scope of inquiry, 60.
Line-wire supports, rent of. *See* Rent of stations, line-wire supports, and conduits.
Los Angeles, Cal., number and horsepower of steam turbines, 42; permits issued in regard to street lighting, 111.
Los Angeles (Cal.) Edison Company, frequency of transmissions, 102.
Louisiana, number and horsepower of internal-combustion oil engines, 42. *See also* States and territories.
Louisville, Ky., number and horsepower of steam turbines, 42.
Lynchburg, Va., power-plant equipment, 100.

Machinery, repairs of. *See* Repairs of buildings and machinery.
Maine, kilowatt capacity of dynamos, 49; decrease in total cost of new construction, 73; gross income from stationary-motor service, 87. *See also* States and territories.
Managers and superintendents, number and salaries of, for commercial and municipal stations (combined), 143; for commercial stations, 162; for municipal stations, 177.
Maryland, number and horsepower of steam engines, 41; kilowatt capacity of dynamos, 49; increase in total cost of construction, 71; cost of construction, for commercial stations, 74; gross income from stationary-motor service, 87. *See also* States and territories.
Massachusetts, horsepower of steam power, 39; number and horsepower of internal-combustion oil engines, 42; of stationary motors, 59; kilowatt capacity of dynamos, 49; lamps, arc and incandescent, 56; meters on consumption circuits, 57; number and kilowatt capacity of transformers in circuits, 58; increase in total cost of construction, 71; decrease in total cost of new construction, 73; cost of construction, for commercial stations, 74; gross income, 82; from commercial and public lighting, 86; from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 88; rates for testing meters, 118. *See also* States and territories.
Materials. *See* Supplies, materials, and fuel.
Mercury vapor lamps, use of, for photographic purposes, 113.
Meridian lamps, number of, 57.
Meters, number and cost of, for commercial stations, 93, 160; for municipal stations, 93, 174; for commercial and municipal stations (combined), 140; testing of, 119.
Meters, electric, data regarding, 117; fees charged for testing, 118.
—— on consumption circuits, number of, for central stations operated by street-railway companies, 17, 181; for central stations and electric railways, 52; for commercial stations, 53, 153; for municipal stations, 53, 165; for commercial and municipal stations (combined), 137; average per station, 60.
Michigan, increase in water power, 43; kilowatt capacity of dynamos, 49; lamps, arc and incandescent, 56; meters on consumption circuits, 57; number and kilowatt capacity of transformers in circuits, 58; number and horsepower of stationary motors, 59; increase in total cost of construction, 71; cost of construction, for commercial stations, 74; gross income, 82; from commercial and public lighting, 86; from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 88; arch lighting, 111. *See also* States and territories.
Michigan Electric Association, data of committee regarding electric heating and cooking, 116.
Minneapolis, Minn., description of arch lighting, 111.
Minneapolis General Electric Company, arch lighting installed by, 111; rates charged, 120.
Minnesota, increase in water power, 43; kilowatt capacity of dynamos, 49; increase in total cost of construction, 71; cost of construction, for commercial stations, 74; gross income, from commercial and public lighting, 86; from stationary-motor service, 87. *See also* States and territories.
Mississippi. *See* States and territories.
Missouri, horsepower of steam power, 39; kilowatt capacity of dynamos, 49; lamps, arc and incandescent, 56; number and horsepower capacity of stationary motors, 59; increase in total cost of construction, 71; gross income, 82; from commercial and public lighting, 86; from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 88. *See also* States and territories.
Montana, increase in water power, 43; in total cost of construction, 71; gross income from stationary-motor service, 87. *See also* States and territories.
Montreal Heat, Light, and Power Company, classes of customers using Gossler system, 113.
Moore tube system, progress in, 113.
Motor service, development of, for refrigerating purposes, 114.
Motors, number and cost of, for commercial stations, 93, 160; for municipal stations, 93, 174; for commercial and municipal stations (combined), 140.
—— stationary, number and horsepower of, for central stations operated by street-railway companies, 17; for central stations and electric railways, 52; for commercial stations, 53, 153, 155; for municipal stations, 53, 165, 171; for commercial and municipal stations (combined), 137, 139; average per station, 60.
Municipal stations, comparison with commercial stations, 13; number of, 16, 29, 30; by dynamo capacity, 26; kind of associated enterprises, 27; supplying and not supplying electric service in cities where located, 32, 33; per cent distribution of income, 34; primary-power machines, 36, 38; number and horsepower of steam engines and steam turbines (combined), 38; of steam engines, 39; of steam turbines, 41; of water wheels, 43; average horsepower per station and per machine, 43; kinds of primary power, 44; dynamos, 46, 47: miscellaneous main-

Digitized by Google

station equipment, 49; substation equipment, 49; output of generating stations, 50; lamps, meters, transformers in circuits, and stationary motors, 53, 60; arc lamps, 53, 54; incandescent lamps, 53, 55; funded debt and interest, 69; distribution of funded debt and interest between electric light and power industry and allied industries, 69; total cost of plants and equipment, 70, 72; of construction, 70; gross income, 76, 80, 173, 176; for stations with and without meters on consumption circuits, 84; from commercial and public lighting, 85; from current sold to electric railways, 87, 88; from miscellaneous electric service, 88; expenses, 89, 95, 179; employees, salaries, and wages, 92, 177, 178; cost of supplies, materials, and fuel, 93, 94, 174, 175; substation equipment, motors, transformers, meters, customers, and output of stations, 165; primary power and generating equipment, 166; analysis of service, 170; character of service, bonds, and cost of construction and equipment, 172.

—— reporting bonds outstanding, capitalization of, 61.

Nebraska. *See* States and territories.

Nernst or "glower" lamps, advantages of, 112. *See also* Lamps, other than arc and incandescent.

Nevada, increase in total cost of construction, 71; decrease in total cost of new construction, 73. *See also* States and territories.

New Hampshire, number and horsepower of internal-combustion oil engines, 42; decrease in total cost of new construction, 73; gross income from current sold to electric railways and to other electric companies, 88. *See also* States and territories.

New Jersey, number and horsepower of internal-combustion oil engines, 42; kilowatt capacity of dynamos, 49; increase in total cost of construction, 71; cost of construction, for commercial stations, 74; gross income, 82; from commercial and public lighting, 86; from stationary-motor service, 87. *See also* States and territories.

New Mexico. *See* States and territories.

New York, horsepower of steam power, 39; number and horsepower of steam engines, 41; of internal-combustion oil engines, 42; of stationary motors, 59; horsepower of gas engines, 42; increase in water power, 43; kilowatt capacity of dynamos, 49; lamps, arc and incandescent, 56; meters on consumption circuits, 57; number and kilowatt capacity of transformers in circuits, 58; increase in total cost of construction, 71; rank, in expenditure for new construction, 73; cost of construction, for commercial stations, 74; gross income, 82; from commercial and public lighting, 86; from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 88; rates for testing meters, 118; legislation in regard to control over meters, 118; uniform accounting in force in, 122. *See also* States and territories.

New York City, primary power and dynamo capacity, for commercial station, 26; number and horsepower of steam turbines, 42; appropriation for fire protection, 114; number of fans for refrigerating purposes, 115; accuracy of meters, 118; provision for "breakdown" service, 122.

New York commission, effort to introduce uniform classification of accounts, 122.

New York Edison Company, equipment of stations, 97; capacity of vertical shaft units, 101; installation of tungsten lamps in public parks, 111; permission to modify contracts requested by, 122.

New York World, description of lighting editorial offices of, 113.

Newark, N. J., use of "flaming arcs," 106.

Niagara Falls, N. Y., hydro-electric development of, 100; frequency of transmission, 102; description of circuit to Syracuse, 102.

North Carolina. *See* States and territories.

North Dakota. *See* States and territories.

Officers of corporations, number and salaries of, for commercial and municipal stations (combined), 143; for commercial stations, 162.

Ohio, horsepower of steam power, 39; of gas engines, 42; number and horsepower of internal-combustion oil engines, 42; of stationary motors, 59; kilowatt capacity of dynamos, 49; lamps, arc and incandescent, 56; meters on consumption circuits, 57; number and kilowatt capacity of transformers in circuits, 58; increase in total cost of construction, 71; cost of construction, for commercial stations, 74; gross income, 82; from commercial and public lighting, 86; from stationary-motor service, 87. *See also* States and territories.

Oil engines, internal-combustion. *See* Engines, internal-combustion oil.

Oklahoma, increase in total cost of construction, 71. *See also* States and territories.

Ontario Power Company, capacity of turbines, 100; of transformers, 104.

Orchard Mesa, Colo., extent of irrigation project, 99.

Oregon, increase in water power, 43; kilowatt capacity of dynamos, 49; cost of construction, for commercial stations, 74; gross income, from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 88. *See also* States and territories.

Output of stations, kilowatt hours, for commercial stations, 16, 18, 50, 153; for municipal stations, 16, 31, 50, 165; for purely electric and composite stations, 19, 20; for central stations, 22, 51; for commercial and municipal stations (combined), 127, 137.

Ownership, character of, 18, 156; total cost of plants and equipment, by character of, 73; number of stations under construction, by character of, 74, 75; cost of construction and equipment of stations under construction, and capitalization of incorporated companies, by character of, 74.

Pacific Gas and Electric Company (Cal.), development of generating plant, 96.

Pacific Light and Power Company (Cal.), reciprocating engines installed by, 97.

Patapsco Electric and Manufacturing Company (Ellicott City, Md.), character of water-power plant, 99.

Pearson, F. J., description of "glower" lighting by, 112.

Pennsylvania, horsepower of steam power, 39; of gas engines, 42; number and horsepower of steam engines, 41; of internal-combustion oil engines, 42; of stationary motors, 59; kilowatt capacity of dynamos, 49; lamps, arc and incandescent, 56; meters on consumption circuits, 57; number and kilowatt capacity of transformers in circuits, 58; increase in total cost of construction, 71; cost of construction, for commercial stations, 74; gross income, 82; from commercial and public lighting, 86; from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 88. *See also* States and territories.

Petroleum, crude. *See* Fuel.

Philadelphia, Pa., number and horsepower of steam turbines, 42; use of motor service for refrigerating purposes, 114; adoption of refrigerating machines by florists, 115.

Philadelphia Electric Company, increase in use of refrigerating machines, 114; number of fans for refrigerating purposes, 115.

Pittsfield (Mass.) Electric Company, oil-driven plant installed by, 98.

Plants, electric-railway, difficulty in securing statistics, 13; isolated, purpose of, 14; power or generating, operation of, 14; primary-power, horsepower of, 31; substation, number and kilowatt capacity of, 136, 152, 165.

Plants and equipment, total cost of, 70; for selected states, 71; by kind of primary power, 72; by character of ownership, 73.

Poles and supports, cost of, for commercial stations, 93, 161; for municipal stations, 93, 175; for commercial and municipal stations (combined), 141.

Population, relation of leading items to, 22; estimated, in selected cities, 23.

Porto Rico. *See* States and territories.

Power, kind of, for stations under construction, 75; purchased, cost of, for commercial stations, 89, 93, 161; for municipal stations, 89, 93, 175; for purely electric and composite stations, 90; for commercial and municipal stations (combined), 91, 141; states reporting largest amounts, 94.

Preferred stock, number of companies reporting, 66; dividend and nondividend paying, 66. *See also* Capital stock.

Primary power, number and horsepower capacity of machines, for commercial stations, 16, 18, 146; for municipal stations, 16, 166; for purely electric and composite stations, 19, 20; for central stations and electric railways, 35, 36; for commercial and municipal stations (combined), 130; by states, diagram, 37; average horsepower per station and per machine, 43; kinds of, 44, 73; total cost of plants and equipment, 72; cost of construction, 74.

Providence, R. I., number of fans for refrigerating purposes, 115.

Public Service Corporation (N. J.), development of generating plant, 96.

"Purely electric," use of term, 13.

Purely electric central stations, number of, 27; gross income, 78; expenses, 90.

Purely electric commercial stations, number and gross income of, 80.

Purely electric companies, number and capitalization of, 63.

Purely electric municipal stations, funded debt and interest of, 69; number and gross income of, 81.

Putnam, H. St. Clair, extract from report to conservation conference, 97.

Quartz mercury vapor lamps. *See* Lamps, quartz mercury vapor.

Railways, electric, number and horsepower of primary-power machines, 35; character of power, diagram, 36; number and kilowatt capacity of dynamos, 44; output of generating stations, 50; lamps, meters, transformers in circuits, and stationary motors, 52; gross income, from current sold to, 87, 88; from service, 142, 158, 159, 176.

Railways and Light Company (Toledo, Ohio), rates for charging automobiles, 115.

Reed, E. G., extract from paper concerning transformers, 105.

Refrigerating machines, increase in use of, 114.

Regulation and rates, data regarding, 120.

Rent, of offices, for commercial stations, 95, 164; for municipal stations, 95, 179; for commercial and municipal stations (combined), 145.

—— of stations, line-wire supports, and conduits, for commercial stations, 95, 164; for municipal stations, 95, 179; for commercial and municipal stations (combined), 145.

Digitized by Google

—— of water privileges, for commercial and municipal stations (combined), 141; for commercial stations, 161; for municipal stations, 175.
Rents, taxes, and insurance, cost of, for commercial and municipal stations (combined), 127; for commercial stations, 158; for municipal stations, 173.
Repairs of buildings and machinery, cost of, for commercial stations, 95, 164; for municipal stations, 95, 179; for commercial and municipal stations (combined), 145.
Rhode Island, number and horsepower of internal-combustion oil engines, 42; decrease in total cost of new construction, 73. *See also* States and territories.
Rochester, N. Y., erection of pole line on back-yard boundary line, 112.
Rotaries, number and kilowatt capacity of, for commercial and municipal stations (combined), 135, 136; for commercial stations, 151, 152; for municipal stations, 169.
Royal Electric Company (Montreal), adoption of Goesler system by, 113.

St. Louis, Mo., number and horsepower of steam turbines, 42; number of fans for refrigerating purposes, 115.
Salaried employees, number and salaries of, for commercial stations, 92, 162; for municipal stations, 92, 177; for commercial and municipal stations (combined), 143.
Salaried officials, clerks, etc., number and salaries of, for commercial stations, 16, 18; for municipal stations, 16; for purely electric and composite stations, 19; for central electric stations and gas plants, 28; for commercial and municipal stations (combined), 127.
Salaries and wages, for commercial stations, 16, 18, 89, 158; for purely electric and composite stations, 19, 90; for municipal stations, 89, 173; for commercial and municipal stations (combined), 91, 126.
Seattle and Tacoma Company (Wash.), capacity of turbine, 100.
Service, electric, gross income from, for commercial stations, 76, 80, 158, 159; for municipal stations, 76, 80, 173, 176; for purely electric and composite stations, 78, 80, 81; for commercial and municipal stations (combined), 79, 83, 126, 142; for stations with and without meters on consumption circuits, 84; for central light and power stations operated by street-railway companies, 182.
—— analysis of, for commercial and municipal stations (combined), 138; for commercial stations, 154; for municipal stations, 170.
—— "breakdown," provision for, 122.
—— character of, 156, 172.
—— miscellaneous, gross income from, 88.
—— stationary-motor, income from, for selected tates, 87.
Sliding scale, use of, 122.
Smoot, C. H., suggestion regarding exhaust of reciprocating engines, 98.
Snoqualmie Falls plant, capacity of turbine, 100.
South Carolina, generating plant in, 22; increase in water power, 43; kilowatt capacity of dynamos, 49; increase in total cost of construction, 71; gross income from stationary-motor service, 87. *See also* States and territories.
South Dakota, increase in total cost of construction, 71. *See also* States and territories.
Southern Power Company, capacity of transformers, 104.
Stanton, Iowa, primary power and dynamo capacity of commercial station, 26.
States and territories, primary power, diagram, 37; steam and water power, diagram, 40; capacity of dynamos, diagram, 48; output of generating stations, 51; comparative summary, 126; primary power and generating equipment, 130, 166; substation equipment, 136, 152, 165; analysis of service, 138, 154, 170; supplies, materials, and fuel, 140, 160, 174; income and expenses, 142, 158, 159, 173, 176, 182; salaried employees and salaries, 143, 162, 177; wage-earners and wages, 144, 163, 178; miscellaneous expenses, 145, 164, 179; primary power and generating equipment, 146; character of ownership, 156; of service, bonds, and cost of construction and equipment, 172; arc lighting, 180; incandescent lighting, 181.
Stationary-motor service. *See* Service, stationary-motor.
Stations, line-wire supports, and conduits, rent of. *See* Rent of stations, line-wire supports, and conduits.
Statistics, grouping of, 15.
Steam engines. *See* Engines, steam.
Steam engines and steam turbines (combined), horsepower capacity of, 38; average per station and per machine, 43. *See also* Engines, steam.
Steam power, comparison with water power, diagram, 40.
Steam turbines. *See* Turbines, steam.
Storage-battery cells, in main stations, number of, for commercial and municipal stations (combined), 135; for commercial stations, 151; for municipal stations, 169.
Street-railway companies, number of stations operated by, 17, 180–182.
Superintendents. *See* Managers and superintendents.
Supplies, materials, and fuel, cost of, for commercial and municipal stations (combined), 129; for commercial stations, 158; for municipal stations, 173.
Supplies, materials, power purchased, and fuel, cost of, for central stations and gas plants, 28.
Supplies and materials, cost of, for commercial stations, 89, 93; for municipal stations, 89, 93; for purely electric and composite stations, 90; for commercial and municipal stations (combined), 91, 127.
—— miscellaneous, cost of, for commercial and municipal stations (combined), 141; for commercial stations, 161; for municipal stations, 175.
Supports. *See* Poles and supports.
Sweet, A. J., physical properties of various forms of lamps summarized by, 110.

Tantalum lamps, number of, 57; per cent of companies using, 109.
Taxes, amount of, for commercial stations, 95, 164; for municipal stations, 95, 179; for commercial and municipal stations (combined), 145. *See also* Rents, taxes, and insurance.
Tennessee. *See* States and territories.
Texas, horsepower of gas engines, 42; number and horsepower of internal-combustion oil engines, 42; kilowatt capacity of dynamos, 49; cost of construction, for commercial stations, 74; gross income, from commercial and public lighting, 86; from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 88. *See also* States and territories.
Toledo, Ohio, use of luminous magnetite arc lamps, 107.
Toledo (Ohio) Gas, Electric, and Heating Company, alternating-current system adopted by, 104.
Transformers, transmission methods developed by introduction of, 104; number and kilowatt capacity, for commercial and municipal stations (combined), 135, 136; for commercial stations, 151, 152; for municipal stations, 169; cost of, for commercial stations, 93, 160; for municipal stations, 93, 174; for commercial and municipal stations (combined), 140.
—— in circuits, number and kilowatt capacity of, for central stations and electric railways, 52; for commercial stations, 53, 153; for municipal stations, 53, 165; for commercial and municipal stations (combined), 137; for selected states, 58; average per station, 60.
Transmission, extension of systems, 102.
Tungsten lamps, number of, 57; improvements in, 109; installation of, 110.
Turbines, steam, number and horsepower of, for central stations and electric railways, 35; for commercial stations, 36, 41, 147; for municipal stations, 36, 41, 166; for commercial and municipal stations (combined), 131; average horsepower per station and per machine, 43.
Turner, M. E., data in reference to use of electrical apparatus for cooking, 115.

Union Electric Light and Power Company (St. Louis), system of rates established by, 121.
Utah, cause of decrease in total cost of plants and equipment, 70. *See also* States and territories.

Vacuum lamps. *See* Lamps, other than arc and incandescent.
Vapor lamps. *See* Lamps, other than arc and incandescent.
Vermont. *See* States and territories.
Virginia. *See* States and territories.

Wage-earners, average number and wages of, for commercial stations, 16, 18, 92, 163; for municipal stations, 16, 92, 178; for purely electric and composite stations, 19; for central stations and gas plants, 28; for commercial and municipal stations (combined), 127, 144.
Washington, D. C., number and horsepower of steam turbines, 42.
Washington, increase in water power, 43; kilowatt capacity of dynamos, 49; increase in total cost of construction, 71; cost of construction, for commercial stations, 74; gross income, from commercial and public lighting, 86; from stationary-motor service, 87; from current sold to electric railways and to other electric companies, 88. *See also* States and territories.
Water power, increase in, 25, 42, 98; comparison with steam power, diagram, 40.
Water privileges, rent of. *See* Rent of water privileges.
Water wheels, number and horsepower of, for commercial stations, 16, 18, 36, 43, 147; for municipal stations, 16, 36, 43, 167; for purely electric and composite stations, 19; for central stations and electric railways, 35; for commercial and municipal stations (combined), 131; average horsepower per station and per machine, 43.
West Virginia, decrease in total cost of new construction, 73. *See also* States and territories.
Wire and cable, cost of, for commercial stations, 93, 161; for municipal stations, 93, 175; for commercial and municipal stations (combined), 141.
Wisconsin, number and horsepower of internal-combustion oil engines, 42; horsepower of gas engines, 42; gross income from stationary-motor service, 87; legislation in regard to control over meters, 118. *See also* States and territories.
Wisconsin commission, decision in regard to rates, 120; effort to introduce uniform classification of accounts, 122.
Wyoming. *See* States and territories.

O

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

3 6105 022 602 390

C3.222:910/SPR/EP

CECIL H. GREEN LIBRARY
STANFORD UNIVERSITY LIBRARIES
STANFORD, CALIFORNIA 94305-6004
(650) 723-1493
grncirc@sulmail.stanford.edu
All books are subject to recall.

DATE DUE

NON-CIRCULATI

Digitized by Google